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## THE PEARY EXPEDITION AND ITS RELIEF.

*By Angelo Heilprin.*

PROBABLY no scientific expedition originating on this side of the Atlantic has attracted more general attention, both at home and abroad, than the expedition which, under the auspices of the Academy of Natural Sciences of Philadelphia, was organized in the spring of 1891 for the exploration of the northern boundaries of Greenland. Its special feature, the traverse in a due geographical course of upwards of six hundred miles of the inland ice, which, if successfully accomplished, will bring the explorers nearly one hundred miles nearer to the Pole than the point furthest reached by man, and probably solve the problem of a possible approach to the Pole itself—at least, from the side from which most attempts to reach the Pole have been made—is the point about which much of this interest centers. The bold manner in which the expedition has been conceived, and thus far carried out, involving an almost total departure from the methods that had been followed by all previous expeditions to the far north, and the circumstance that the party of exploration is reduced to less than a handful of men, lend additional interest to the enterprise.

To the scientist the interest is more than a purely sentimental one. The successful issue of the expedition means the solution of some of the most perplexing problems which yet lie in the field of the investigator. To the ethnologist it brings a picture of the conditions which determine the limitation of man's habitation on the globe, for nowhere else are the resources of nature, whence

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man's needs are supplied, so restricted as they are here. The simplicity of life finds its zero in the ice-fields of the north, and it is there that the struggle for existence sees a natural interpretation of the pure philosophic conception—a battle for life almost wholly independent of the protective and discriminating tendencies of civilization. No people on the earth's surface are so completely isolated, or shut out from the "light of the world," as are the northern Eskimos; what they are, whence they come, and whither do they tend, are questions to which the ethnologist has not yet ventured to give answer. Our knowledge on these points is still deplorably defective. It may appear surprising that in so interesting and important an inquiry as the development of civilization so little attention should have been paid to the conditions of these primitive people—a people of the simplest habits, one might almost say rudimental habits, but yet endowed with a perceptive faculty which is no less astonishing than is the high regard for personal honesty which they maintain. Until Franz Boas a few years ago reached the Eskimos of the American waters no truly scientific study of these people had been attempted; their inaccessible position has pretty effectually barred out the investigator, whose opportunities are almost wholly centered about the occasional dashes in the direction of the Pole which are fostered by a "weak-minded" government or by equally weak-minded scientific associations.

To the geologist the Peary Expedition cannot easily fail to be fruitful of the most important results. No topic, except possibly that of the origin and development of life-forms, has entered so largely into his discussions—indeed, into the discussion of the scientific world generally—as the "Great Ice Age," that recent period in the history of our planet which was marked by a vast accumulation of ice and glaciers over much of the northern half of the northern hemisphere; when the valleys of New England and the Middle States were buried thousands of feet under moving ice, when Great Britain radiated off her glaciers into the adjoining seas, and when the glaciers of the Alps moved irresistibly into the heart of Germany and France, and annihilated Switzerland except as to mountain peaks and crumbling ice-masses. Every year of investigation has thrown some new light on this darkest problem of geological physics, and presumably brought us nearer to a true appreciation of the conditions which governed the advent of an era so remarkable as the Glacial Period, and permitted of the accumula-

tion of so vast a deposit of snow and ice. Greenland of to-day may or may not be a relic of this past period of ice; whether it is or is not, it is the only country which carries with it the physiognomy of the ancient glaciated tracts, where the valleys are buried beneath thousands of feet of moving ice, and where, in fact, the surface contours of the region are not those of the rock-masses out of which it is built up, but of the snow and ice-masses which have resolved all the inequalities into a nearly uniform level. This was much the condition of New York and of the New England States when man seemingly made his first appearance in the region. It is but natural that to Greenland the eyes of the savant should be directed for a possible solution of the enigma which has been an

PEARY'S QUARTERS, MC CORMICK BAY.

*ignis fatuus* to the scientific world for upwards of forty years, or from the time when the elder Agassiz propounded his brilliant glacial generalization; and it is almost safe to say, with the Duke of Argyll, that no satisfactory explanation of the phenomena in question can be had until we become better acquainted with the physiography and dynamics of northern Greenland.

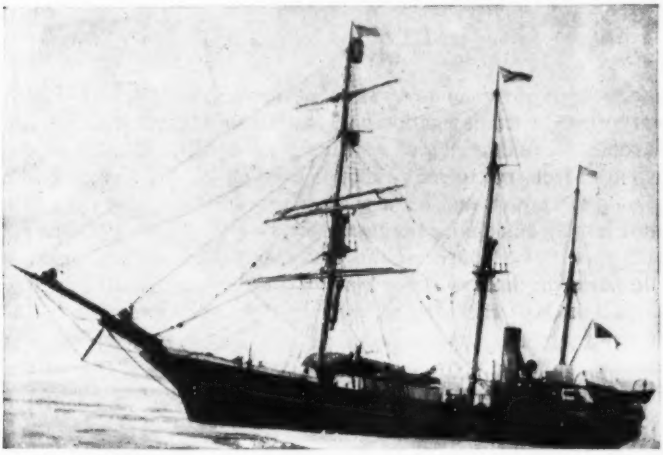
By the geographer the results of the Peary Expedition are awaited with no less interest than by the scientist. The question as to whether Greenland is a vast island or a continental mass stretching off to the Pole, or northeastward in the direction of Spitzbergen and Francis Joseph Land, is one which has long engaged

the minds of geographers but has thus far entirely baffled solution. The gallant effort of Lockwood and Brainard, members of the Greely party, who planted the American flag in Latitude 83° 24′, added something to our knowledge during the last decade, but only enough to leave the question as undecided as it was left after the explorations of Kane, Hayes, Hall and Nares. And until the question is determined the most significant blank on our maps must remain as such to be filled in by future discovery. Now that the ultimate sources of the Nile and Congo have been pretty definitely located, the mysteries of Equatorial Africa and Central Australia cleared up and the contours of the oceanic bottom traced, the determination of the boundaries of Greenland remains as the most important problem to be solved by the geographer.

Hitherto the exploration of the far north has been conducted mainly upon the open surface of the water, or upon the pack-ice and floes which have accumulated as the result of a single winter's freezing or of the frost of a successive series of winters. In either case the limit of exploration has been definitely fixed by the conditions of the sea, which, as events have shown, only too plainly baffle the efforts of the most skillful and venturesome of navigators. The feature of Peary's exploration is its independence of water conditions; conducted entirely on the mainland, it heeds neither storm nor ice-floes, but pursues an even tenor on a surface which nature has herself prepared as a highroad of travel, free from the excitement of both "nip" and crush. What substitute dangers, if any, the expedition may encounter in its traverse of the inland ice cannot be told until the return; nor, indeed, can it be foretold with certainty that the plan of exploration as conceived can be in fact carried out. Starting from his base (the present winter-quarters) on McCormick Bay, on the northwest shore of Greenland in approximate Latitude 77° 43′ N., it is the intention of Lieutenant Peary and his associates to strike at once into the interior, following on the ice-cap, so far as it is possible, a nearly due northeast course in the direction of the Atlantic. The writer found by barometric measurement that the summer-position of the ice-cap was at its lowest point about 1900 feet above the level of the sea, below which the mountain slopes were almost entirely destitute of snow. Once having gained the snow line on the back, probably, of one of the flat glaciers descending into McCormick Bay, the line of travel will be carried over a more or less even, but on the whole ascending, surface, the nature of which is not unlike the granular ice-crust or

névé which fills in the glacier-feeding basins of the Alps. There is nothing more delightful than a passage over this inland ice on a clear and quiet summer day ; the terrors which the mind conceives regarding Arctic travel are entirely foreign to it ; nothing but peace and desolation meet the traveller on an occasion of this kind. All about is but a barren expanse of snow and ice, here and there, perhaps, relieved by a projecting crag or partially buried mountain-pinnacle. The foot sinks beneath the surface to a depth of possibly three or four inches, sometimes less, while the snow-shoe glides over it as it would over a surface of adamant.

It is not easy to estimate the distance or amount of travel that



"NIPPED" IN THE ICE, JULY 4.

can be accomplished for a number of consecutive days. Where the surface is compact and but gently rolling, travelling is at least as easy as on an average country road, and with or without snow-shoes twenty to twenty-five miles, or more, can readily be covered in twenty-four hours, especially at a time of the year when a generous midnight sun gives to the travellers the benefit of a continuous day. Lieutenant Peary's estimate of travel is based upon an assumed daily average of 18–20 miles. This seems to me to be an overestimation of possibilities, or at least of probabilities. It takes little account of the contingencies of travel which present themselves in a region of this kind—the snowdrifts, the

MELVILLE BAY PACK, OFF CAPE YORK.

interposition of rifts and crevasses, of fogs and storms, and of contrary winds, when navigation on "ski" or snow-shoes is all but impossible. The dragging of a sledge, loaded with material to the extent of from 150 to 200 pounds is even on a flat surface a brake of no mean power, and on a smooth ascending slope a drag that must largely antagonize the best efforts of the "skiers." The return route, as planned to the 85th parallel of latitude, making allowance for detours of one kind or another necessitated by the irregularities of the surface, involves a journey over the ice of probably not less than 1400 miles, which, to be accomplished in little more than ninety days, necessitates a daily traverse of approximately fifteen miles. It seems hardly likely, even with the records made by Aldrich and Markham and Lockwood and Brainard, that this rate of speed can be maintained for so long a period, even assuming no accident or sickness of any kind befalling the members of the party; and still less probable does it appear when we read of the difficulties which were encountered by Nansen in his traverse of southern Greenland, and the exceeding slowness of his journey. As this traveller remarks, the actually determined daily rate of advance was barely one-half of that which had been roughly assumed or calculated. It is more than probable, however, that the region to be traversed by Peary is much more favorable to rapid locomotion than that passed over by Nansen; the height of land is seemingly much less, while the presence of a continuous sun, in addition to giving additional hours for work, precludes that suffering from an extreme cold which must necessarily befall the trespasser of the southern highlands in a region of alternate night

and day. It is not likely that the expedition will experience any really severe cold, except possibly in the initial stage of the journey (in the month of April following or the beginning of May). Lieutenant Peary's experience on the inland ice of Greenland in 1886 must certainly have taught him what are the possibilities of travel in that inhospitable region, and, doubtless, it serves as the basis for the computation which has seemed, to the originator of the expedition, to indicate a successful issue. While less enthusiastic minds might be skeptical to a degree as to the result, it should be said that the extraordinary energy and adaptation to travel which Mr. Peary possesses, combined with a most vigorous constitution, will, doubtless, work to his advantage to an unusual degree, and not unlikely accomplish for him what comparatively few travellers could look forward to with anything but hope. To what extent the unfortunate accident—the breaking of his lower right leg—which befell him on his up-journey will hamper him in his movements cannot, in the nature of things, be foretold.

The one seriously weak point in the Peary Expedition was the failure to make adequate provision for a return to civilization after the accomplishment of the inland journey. It was the intention of the leader to make his way leisurely down the coast in open whale-boats—two of which were specially built for the purpose—to a point about opposite Cape York (Lat. 75° 56′), where it was hoped chance would throw in the way of the party one of the fleet of steam-whalers passing westward to the American whalers; in the event of no such vessel being met with, the journey was to be continued across Melville Bay to the Danish settlement of Upernivik. The first condition has been found impossible by reason of the fact

UPERNIVIK, THE MOST NORTHERN "COMMERCIAL" SETTLEMENT IN THE WORLD.

that the whalers pass the point in question a full month in advance of the time that it could be reached by the returning Peary party; the alternative is accompanied with such hazard that, except under the most favorable circumstances, the probabilities would be against, rather than in favor of, a successful issue. The passage in open boats of Melville Bay has been accomplished, either in whole or in part, on several occasions—by Kane, in 1855; by Bessels and Buddington, in their retreat from the *Polaris*, in 1873; by Pike and Garlington, in their retreat from the *Proteus*, in 1883—but always with great difficulty, and under the guidance of an ample force of able-bodied men. In the present instance, the party, including the courageous wife of the commander, numbers but seven members, too limited in strength to undertake the risks which the journey entails, especially after the exhaustion which must necessarily have been brought about by the traverse of the inland ice. Under the circumstances it seems eminently proper that assistance should be rendered to the returning party, and it is with a just appreciation of this position that the Philadelphia Academy of Natural Sciences has undertaken the organization of a relief expedition.

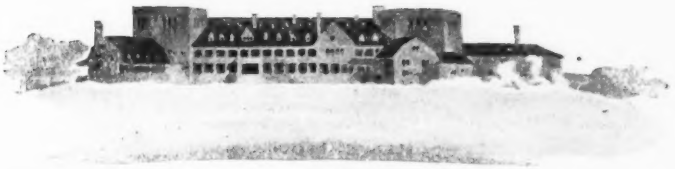
No definite plan for the relief has yet been officially outlined or decided upon, the subject in all its details being in charge of a committee of scrutiny. In all likelihood, however, the relief vessel will leave St. Johns, Newfoundland, in the last week of June, so timed as to reach the front of the Melville Bay "pack" a few days in advance of the breaking up of the ice. This usually takes place about the third week of July, when the ice finally passes westward to the American waters, to be there drifted south by the southerly-trending currents. Occasionally the "pack" parts earlier, and, indeed, under very exceptionable conditions, the dissolution might take place already in the month of June; on the other hand, years are known when the ice has at no time completely separated. So far as it is possible no attempt will be made to force the ice, as in an ordinary season little advantage can be gained over patiently waiting for the ice to take its own natural course, and then following in its wake. The uncertainties of "butting" and its attendant dangers are such as to make slowness a profitable measure of safety. Once beyond Cape York, Latitude 75° 56′, at the northwestern extremity of Melville Bay, the North Water opens up a free field for navigation, and an easy passage can be made in about a day and a half to McCormick Bay. Some members of the Peary party, among them Mrs. Peary, will be met there.

CAPTAIN RICHARD PIKE.

[Captain of the "Proteus" of the Greely Expedition, 1881; of the "Proteus," of the Garlington Rescue party (after Greely) crushed in the ice, 1883; of the "Kite," and of the Natural Science Expedition of 1891. Probable Captain of the Peary Relief Expedition of 1892.]

It is expected that the Relief Expedition will reach McCormick Bay between the 21st and the 25th of July, a few days in advance of the time when Lieutenant Peary himself hopes to descend from the mountain heights to again seek the comforts of civilization—the embrace of his gallant wife and the shelter of boards and tar-paper. In an official communication addressed to the Academy of Natural Sciences—brought back by the West Greenland Expedition of 1891—Lieutenant Peary specifies as the probable time of his departure (retreat) from McCormick Bay some portion of the first or second week in August, which would be between two and three weeks after the arrival of the relief party. It is impossible to say in advance what plan of action will be determined upon by the relief party in the event that Mr. Peary and his associates, through whatever cause, should fail to return at about their schedule time. The contingencies of search in the region are such that no anticipatory methods can be advantageously formulated; the line of action must be determined by the conditions which present themselves on the spot. We can but hope that no mishap has befallen the explorers, and that they will in due time be ready to respond to the call of a voyage home. A delay of a few weeks will still be in the margin of safety for a clear passage southward, as Melville Bay rarely begins to freeze over before the middle of September.

The question as to what practical benefits are to be derived from the Peary Expedition, or from expeditions of a like nature, cannot, perhaps, be directly answered. They may or may not discover new fields of labor and reward or peculiarities of existence which had not hitherto been suspected, but they are of inestimable value in rendering such discovery possible. It is not merely the question as to whether the mineral wealth of the Arctic north is such as to render mining profitable, or whether a serviceable passage for navigation can be obtained across or through the ice; it is the relation of this exploration to other exploration which makes all "adventurous" enterprise of this kind significant and important. To no other class of workers is mankind more largely indebted for what it enjoys than to the traveller and explorer, whether he be an explorer of the wilds of Africa or Australia, the transgressor of the northern ice-fields, or the discoverer of a continent. They are all members of a fraternity who unitedly work to a common end—the elucidation of the mysteries of our planet; and it is the province and duty of man to know all that belongs to his habitable globe, its every feature of mountain, sea and river.



# WHAT AN ARCHITECT DOES FOR HIS MONEY.

*By John Beverley Robinson.*

"HOW many houses can you draw in a day?" said an old dame to a well-known Boston architect. She was surprised, no doubt, to learn that to "draw" the smallest kind of a country-house is the work of several days; that a month is easily used in the architectural work upon a large house; while for a Vanderbilt or Villard house it would require the equivalent of one man's time for several years. Of course there is a great deal to be done besides "drawing," but, the drawings being the most conspicuous result of the architect's labor, most people overlook his less-easily perceived services. Conceiving of "drawing" as such a performance as they learn at school in their drawing-books, they naturally are without any conception that a single drawing for an elaborate building may take a fortnight of steady work to complete it. Such a lack of acquaintance with the methods of other occupations is perhaps inevitable, together with the lack of appreciation that goes with lack of acquaintance. The farmer knows not the difficult problems that the lawyer has to work out, and the lawyer cannot see that the farmer does any head-work at all.

Most of us have at times sat down on a winter evening with a companion, wife, brother or friend, to devise and to depict on paper the perfect house which we proposed building, at once or eventually, in which all the imperfections dear to the hearts of architects were to be avoided, and all the beauties and conveniences which they did not usually think of were to be embodied. Hot-water heating we would have, to begin with; and an elaborate ventilating apparatus; and oak floors,—ah, yes! we must have oak floors throughout; and hard-wood doors and things, because we knew a man who would make hard-wood doors cheaper than painted ones, he had actually done so for Mr. Brown; and we would have

plate glass and frescoed ceilings, and tiled bathrooms and plumbing !—such perfect plumbing, at that, with a device of our own, involving three cess-pools and a grease-trap. Three thousand dollars, too, was all it was to cost; we knew a house very nearly like it that only cost twenty-five hundred and we were sure that the trifling additions we had made would not cost over five hundred more. So after many days of observation of balconies and bay-windows and towers, we "drew out" our ideas, depicting a staircase, in imagination, of generous proportions, and assigning to it the space of a small closet on paper, and we rejoiced with the joy of creating.

The business of an architect, it must be remembered, like that of every technical designer, is not to devise schemes of ideal excellence, but to design the best that can be done for the money. There are many other limitations, of utility, of situation, of strength of materials, of available skill and means, but above all stands the question of cost. The knowledge of what is desirable is already in the possession of the architect. The information about bay-windows, and porches and pretty scraps here and there, which the intending house-builder acquires by a long process of walking or driving about, is already the architect's, gained by many years of education and experience, together with photographs and books in which he knows where to find a record of such things. He has his pet schemes and picturesque ideas all ready for use when opportunity presents, dozens of them; but he knows, as people out of the business do not know, that such are rarely available unmodified.

The very first thing that must be done when the architect is about to begin work upon a building is to obtain as full information as possible about the conditions—the kind of building both as to appearance and as to use that his client may have a prepossession for, the amount of money that will be spent, and whether the sum mentioned is intended to include everything, furnace, chandeliers, sidewalks, and so on, or the bare structure only; following these principal points, questions of detail that may have an important bearing, whether the site is rocky and cellars therefore costly, or whether it is on a slope which can be used to advantage, what kind of water-supply, the exposure, the prevailing winds and sunlight, possibilities for drainage, appearance of surroundings—upon all these points, and upon as many others as may be, must information be obtained.

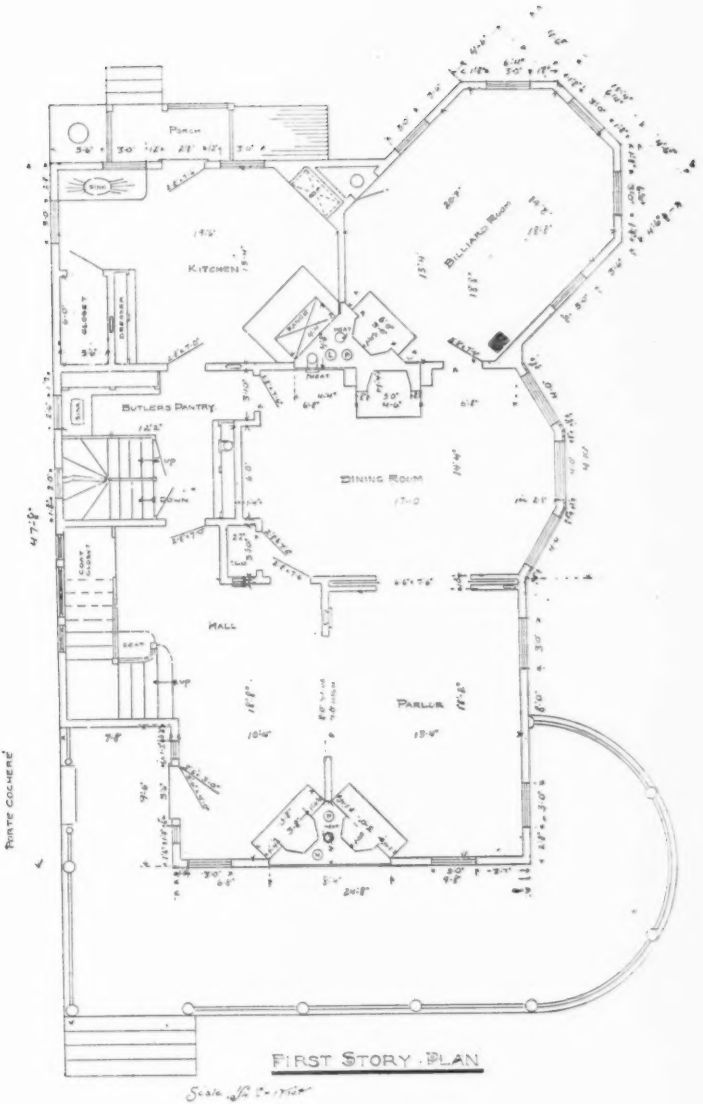
That done, out of the many schemes and ideals continually

INTERIOR OF STAIRCASE HALL, BY CHARLES T. MOTT.

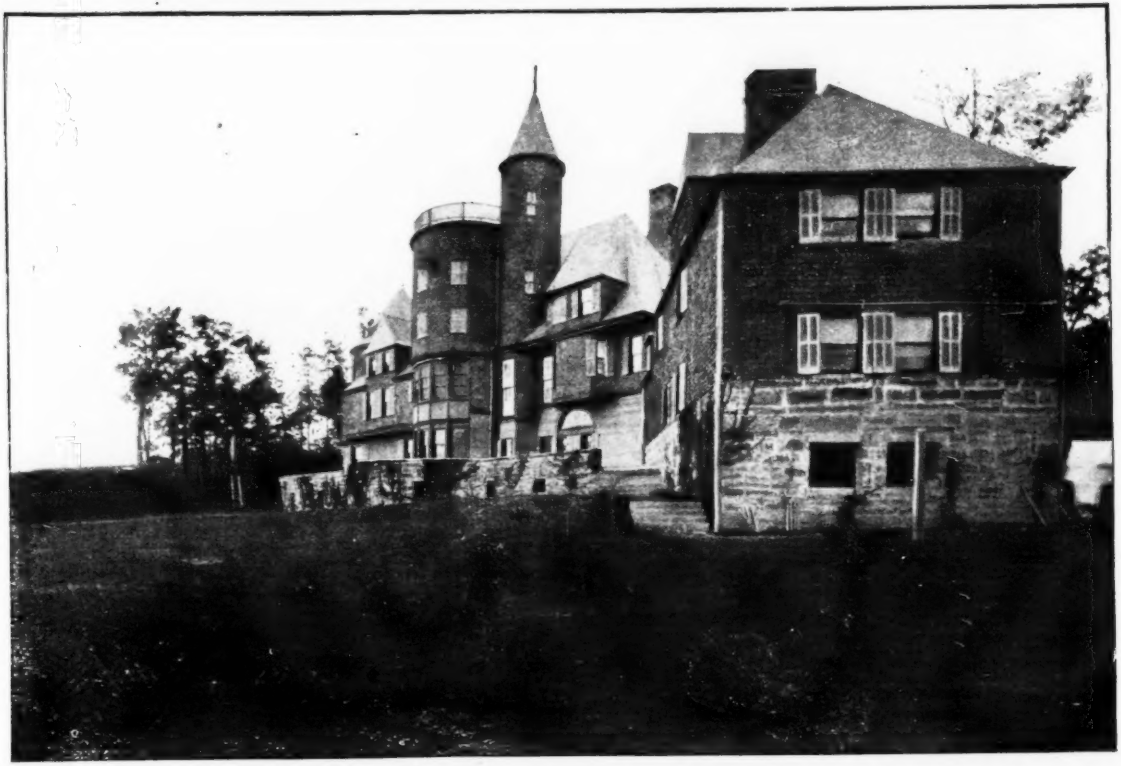
floating about in his mind the architect selects one, or more probably evolves a new one. A "motive" for the building is first determined, which means, in architects' language, the leading idea of a design. The process of getting at a leading idea is not usually spontaneous nor instantaneous. It means sitting down at a drawing-board and experimenting with ideas, drawing out each until some insurmountable obstacle is encountered, modifying or rejecting and developing new ideas, until *à force de forger*—an available project—is evolved. This is what architects call "study." "A good motive, but it needs more study," is a frequent criticism.

When the general design of the building is determined and noted in perhaps a few lines and scribblings that would seem to have been made in ten minutes, a preliminary sketch is made. The proposed interior arrangement is shown as "ground plans," the exterior often perhaps in a half-pictorial sketch. Even if the architect makes no exterior drawing he has usually got something in his mind by the process of devising the interior. On the other hand, if he makes an exterior sketch, he usually has a pretty clear idea of what ought to go inside. The divorce between outside and inside in the unprofessional mind does not exist in the mind of the architect. With him outside and inside are parts of a whole, and neither can be much changed alone.

ELEVATION OF COUNTRY HOUSE—BERG & CLARK, ARCHITECTS.

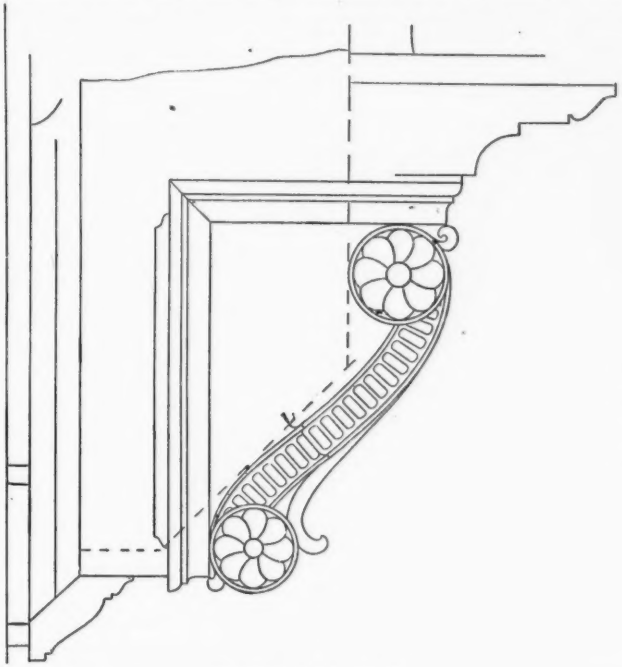



PLAN OF COUNTRY HOUSE, BY BERG & CLARK.



COUNTRY HOUSE IN WEST VIRGINIA—CHARLES T. MOTT, ARCHITECT.

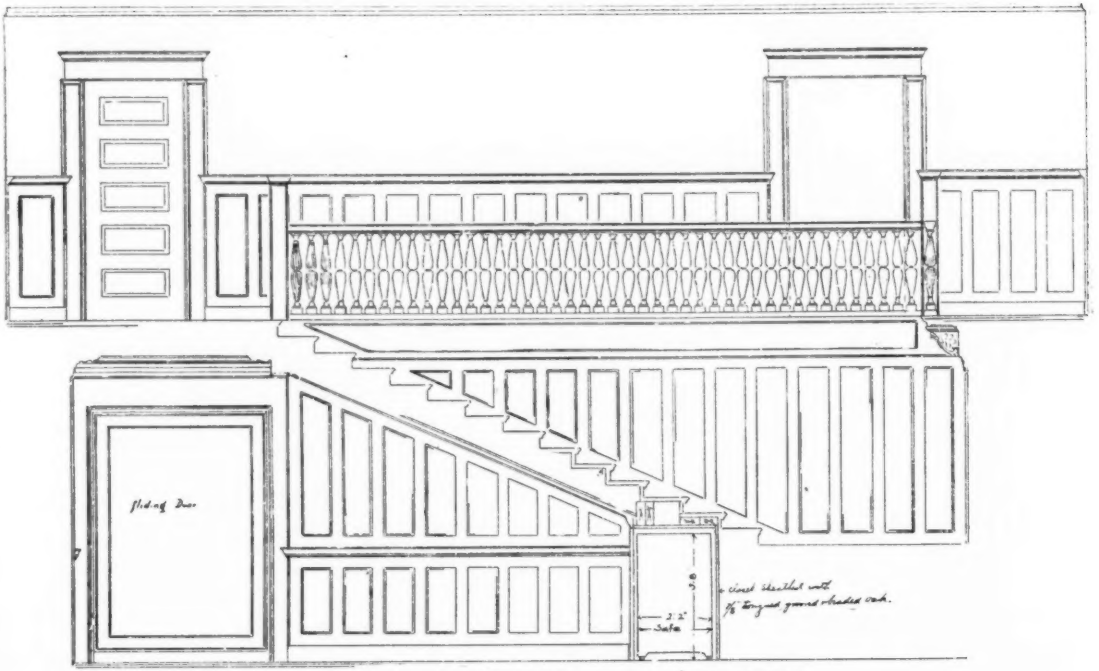
The headpiece of this article is a sketch for an exterior by Thayer & Robinson, which never advanced beyond that point. The large towers are supposed to be, one a dining-room, the other a ball-room, each extending the whole height of the tower. The middle portion contains parlors, bedrooms, grand staircase, library and so on. The wing to the left is the ladies' domain, with boudoirs, lunch-rooms, and dress-maker's conveniences ; the diagonal wing coming forward



BRACKET FOR A STAIRCASE.

contains gun-room, smoking and billiard-rooms, and men's arrangements generally ; beyond to the right are kitchens and other offices.

Such "sketches" are quite usually drawn to a scale of eight feet to an inch, or, if in a perspective view, scale is merely guessed at. Preliminary sketches are not available to build from, as exact sizes and materials and methods of construction do not need to be determined at this stage, but they contain the artist's conception and are valuable accordingly.




SCALE DRAWING FOR STAIRCASE—CHARLES T. MOTT, ARCHITECT.

On another page is a sketch for a ceiling decoration for a very large country house, by Charles T. Mott, of which a photographic view as built is also given. In the construction of this house about three hundred drawings of all kinds were made.

Let us suppose that the preliminary design has been approved by the client, with or without modifications; the next step of the architect's work is to express the design so clearly that the work can be built from it, and so that the builders can make accurate estimates beforehand in case the building is to be built by contract, as is usually done. Before these working-drawings are made, together with the written technical descriptions, called specifications, no trustworthy estimate of cost is possible. The same house may cost from $3000 to $10,000, according to the way it is built and finished; and as the architect can have little to guide him before the working-drawings and specifications are done but a general notion of the size of the building required, it is impossible for him to do more than approximate in the roughest way the cost. He, too, like the client, is anxious to get all he can for the money. He, too, like the client, is often led by the flattering tale that hope tells to try to get more into his design than the appropriation will pay for; and he is no less grievously disappointed than the client when the actual bids to do the work make it necessary to cut off cherished features.

The working-drawings are double the scale of the sketches—four feet to an inch—quarter-scale drawings is the office word. The work of translating sketches into working-drawings involves almost as much head-work and vastly more hand-work than did the making of the sketches themselves. Arcades, which in the sketch seemed to permit seven arches very nicely, are limited to five by the reduced dimensions of certain rooms; the low and picturesque window of the sketch must be raised for necessary light, though at the cost of appearance; the lofty gable must come down for fear of running the cost too high. Sheet after sheet of tracing paper, that refuge of designers, is used in studying each feature. The result is a set of large, fair drawings on transparent tracing cloth, the ground-plans sufficiently like the sketch-plans, but the exterior reduced to mere "elevations," masses of but slightly expressive straight lines, with here and there some enrichment. But the information is all there. Figures showing the dimensions are peppered over everything. Red crosses here and there mark gas-lights. Diagonal lines pointing right and left show where and which way

doors are hung, and the sizes of these are marked. Plumbing-pipes in blue lines ramify over the foundation plan and elsewhere, and all sorts of information in the form of "notes" is freely sprinkled.

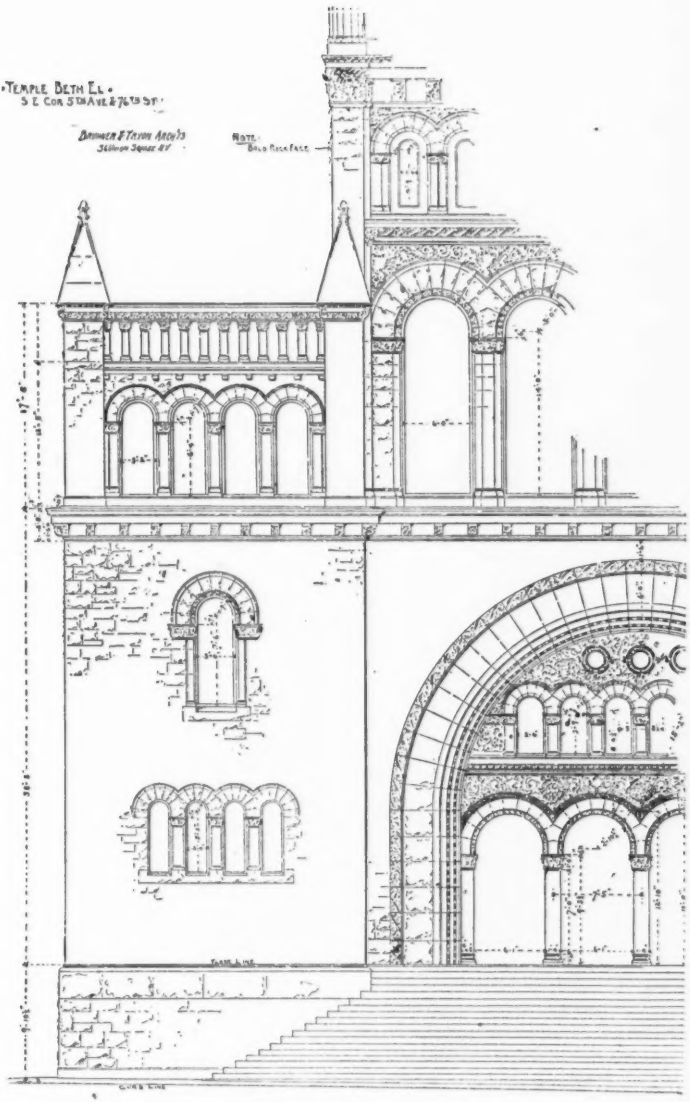
A first story plan and side elevation of a country house by Berg & Clark are shown in another illustration. The great reduction that is necessary to bring an architectural drawing within the size of a magazine page causes some loss of clearness and of interest.

There is also shown a portion only of an elevation of the recently completed Temple Beth-El by Brunner & Tryon. The original drawing was about four feet square—too large to reproduce entire.

SKETCH FOR CEILING—CHARLES T. MOTT, ARCHITECT.

Along with the making of the quarter-scale drawings goes the writing of the specifications. Each part is separated from the rest in proportion to the size of the building. For a very small house carpenter-work and mason-work and all, except perhaps plumbing and heating, will be specified in a general specification.

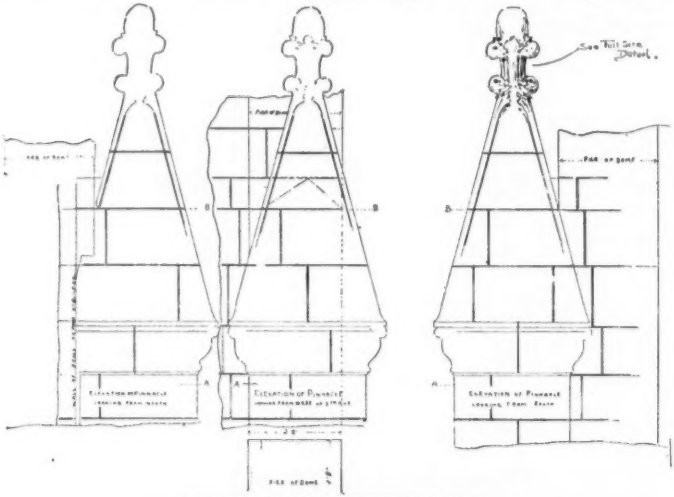
In the most elaborate work there will be perhaps a dozen specifications for one building. Mason-work, carpenter-work, cut stone, iron-work, plumbing, heating, gas-fitting, plastering, roofing and so on, each has its written description to itself. The usual quota is




ELEVATION OF TEMPLE BETH-EL, BY BRUNNER & TRYON.

three—masons, carpenters and plumbers, with others according to the exigencies of the case.

Then comes the tedious process usually of getting estimates. Duplicate copies are obtained of drawings and specifications, of the former usually by some sun-print or hectograph process, of the latter typewritten or printed. Notices are sent to the various contractors and on a certain day all the bids are opened and a contract made with the lowest bidder. Simple enough, and expeditious enough when all goes well, but what with the difficulty of choosing men to estimate, men of good standing, but not of too good standing, unless we are prepared to pay the price of the best possible



DETAILS OF PINNACLES OF TEMPLE BETH-EL.

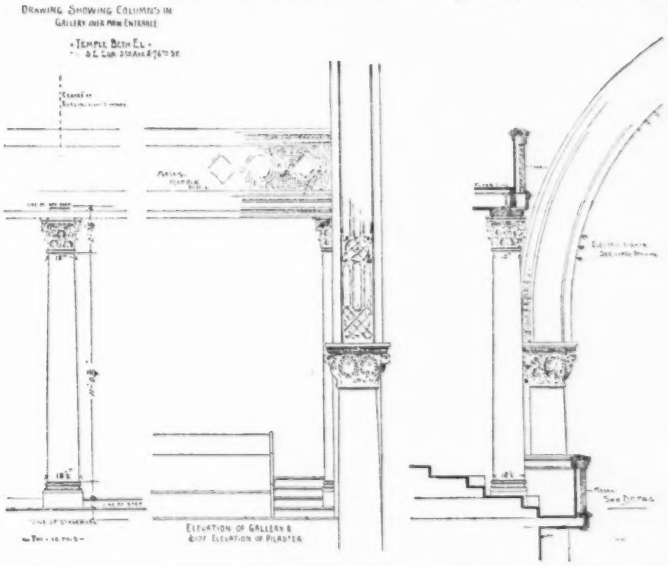
work, what with the further difficulty when all the bids come in so high that none can be accepted, yet when it seems reasonable to think that lower bids can be obtained, and the whole performance must be gone through again, what with these and other delays and difficulties, the business of getting bids is not usually accomplished without much effort and annoyance.

As soon as the contracts are made come more drawings to be made, framing drawings, large-scale drawings of portions of the exterior, drawings for trusses, for iron work, for special parts of all sorts. Then come, too, full-size detail drawings of the ornamental parts outside and inside throughout the building.

A detail drawing is given of a single pinnacle of the same elevation of the Temple Beth-El as well as detail drawings of the interior galleries.

Other detail drawings are shown of a staircase hall by Charles T. Mott and a photograph of the completed work, together with a full size drawing of one of the brackets seen under the balustrade.

Preceding this there comes, in cities, the job of obtaining a permit from the authorities, of making palaces conform to rules devised to control tenement-houses, of convincing the genial politician



DETAILS OF GALLERIES OF TEMPLE BETH-EL.

in charge that you are not a deep-dyed villain, and of receiving with a smile his well-meant criticisms upon your morals and intelligence. After all is done the building is begun. The hole in the ground is dug and from the first spadeful of earth to the last lawsuit by lienors the work of direction endures. Superintendence or supervision it is sometimes called, but direction is a better word to describe the function, and is coming rapidly into use.

It is not the office of a detective to see that the rascally builder does good work, contrary to his known habits, though such is a prevalent opinion. It is rather the function of looking out for

everything. Seeing at the start that the lines of the building are right, watching, as the digging-out goes on, to see whether there is going to be good soil for a foundation, and remedying unforeseen difficulties, as rocks, springs and quicksands; getting the owner to determine early in the work what range, pump, elevator, gas-machine and what not he will use, or choosing them, if requested, for him, and having the mason-work built to fit all of these. Add to all these and a dozen more of such matters to be anticipated and provided for, the continual solution of constructive conundrums proposed by various mechanics, and the continual settling of various contentions among them.

With a good contractor the rejection of bad work is the rarest duty of the architect and the best service he can do his employer is to see that he has none but good contractors. Finally comes the matter of auditing bills and certifying payments on contracts. It is the most delicate and one of the most important things an architect has to do. His certificate, although of course it may be impugned, is such strong *prima facie* evidence of the rightfulness of a claim as to be most valuable either to contractor or owner. His only safety is in exact rectitude, whether it be that the client is dissatisfied with work which the architect knows is as good as called for even though not perfect, or whether it be the contractor who while perfectly "square" has made an unfortunate error in his estimate and stretches things a trifle to recoup himself, the architect must stand clear as far as possible from prejudice, fear or favor.

After all, when an architect does all of his duty so perfectly that there is no hitch nor trouble from beginning to end, his real service in accomplishing so desirable a result cannot of course be seen. Everything goes so easily, why, anybody can direct the construction, would be the feeling. Judge an architect's efficiency not by the little snarls that are almost inseparable from a long protracted and complicated building-operation, but by the substantially successful result which is only obtained by arduous and continuous exertions that never come under the client's observation.

# WORTHLESS GOVERNMENT ENGINEERING.

## A REJOINDER.

*By George Y. Wisner, M. Am. Soc. C. E.*

THE paper with the above title published in the January number of this magazine, has called out replies from Colonel King and Major Ludlow of the United States Engineer Corps, the former in THE ENGINEERING MAGAZINE for February, and the latter in the *Marine Review* of January 14, 1892.

They evade the principal issues by shifting the responsibility for failure, and by personal insinuations and general fault-finding because the writer did not descend to the same line of argument and play the rôle of army informer. Personalities and insinuations neither prove nor disprove statements, and although reputable civil engineers are willing to join in any legitimate discussion that will have a tendency to place the public works of the country on a better business basis, they have neither time nor inclination to indulge in personal epithets, and gladly leave to the Corps of Engineers a monopoly of the code of ethics thus outlined.

The public has but little interest in the eccentricities of the individual members of the Corps, but if the system and method under which they expend the appropriations for rivers and harbors can be remodeled so that the results and benefits may be doubled, it does become a matter of public interest, and one well worthy the candid consideration of statesmen as well as engineers. So long as this object be accomplished, it is immaterial whether the present organization be remodeled so that engineers may become experts in its various branches and the business of the Corps conducted in a more expeditious and economical manner, or whether an entirely new bureau of engineers be organized for this purpose, that the military engineers may be relegated to the charge of fortification work, for which they have been educated. In either case, to be successful a symmetrical system must be adopted; one in which caste is not a controlling element, and in which promotion from the lowest to the highest grade depends on merit and success.

Under the present system the civil assistant engineer cannot hope to advance beyond a certain fixed grade, either in position or

pay, and no matter how successful his work may be the credit for it must go to his superior. The result of this has been that civil engineers in Government service become dissatisfied by the time their services are of more value than the Corps will recognize, and resign their positions whenever opportunity offers to engage in private work. It should be mentioned, however, that it is a part of the unwritten code of the Corps to prevent assistants from obtaining offers of better positions if their services are desired by their superior officers.

Some of the works mentioned by Colonel King as having been "skillfully, successfully and economically executed by the Corps of Engineers" are good examples of works designed and executed by civil assistant engineers—men whose names do not even appear on the final elaborate descriptions, and in which works the officers in charge have made use of the inventions of civil engineers without compensation, well knowing that suits against the Government are not likely to be decided in an ordinary lifetime.

On pages 1470 and 1471 and plates IX, X and XI of the Report of the Chief of Engineers for 1889 will be found a detailed description of a concrete jetty wall, and plant used in its construction, designed and built by the writer for a private company, but which is so incorporated in their report as to lead the casual reader to infer that the work was designed and executed under their direction. After the Corps of Engineers has thus undertaken to absorb the credit for the plans and work of a civil engineer, Major Ludlow, an officer of that Corps, states that "this engineer's experience has been mainly that of a surveyor, not a constructing engineer; nor is any work that he has carried to a successful conclusion recalled to mind." As a specimen of officialism and individual effrontery this is unique.

Mr. Weller's advice in the celebrated Pickwick case was "Never mind the character but stick to the alibi. Nothing like an alibi." A careful perusal of Colonel King's defense of the Engineer Corps leads one to infer that he is thoroughly imbued with the same opinion; for while the fact remains undisputed that millions of public money have been wastefully expended under the direction of the Engineer Corps, the only defense seems to be that some other department was to blame, or some other party has done something worse.

It is true that when fourteen years are taken to do work that ought to have been done in four, the expense is largely increased;

yet this will hardly explain why $3,132,000 is now needed to complete a work for which the original estimate was only $1,800,000, and on which $2,203,000 has already been expended. The Treasury Department may be to blame for the red-tape system with which so much fault is found, yet we do not hear of any effort by the Corps to free itself from the burden.

It is true that the Light-House Board is not a part of the Corps of Engineers, yet the engineer officers detailed for service on that Board and in charge of the engineering works of the different Light-House districts do have charge of making the plans and specifications for and the building of structures needed.

Colonel King is undoubtedly correct in saying that "the plan of inviting engineers and contractors to submit plans for such an important work as Diamond Shoals Reef Light-House, has certain advantages,"—advantages that will in all probability give the Government much better results than if the work was done under the direction of the Corps. But this is evading the question at issue. If the Light-House Engineers are educated and supported at public expense for the purpose of planning and conducting such works, why should a second party be requested to relieve them of all responsibility on dangerous undertakings? Would it not be better to have some such men in the Light-House service, and thus avoid paying two different sets of engineers for performing the work that one should do? This contract, although for a different character of work, involves the same principle as that so bitterly opposed by the Corps in the work done at the mouth of the Mississippi River, where civil engineers in three years time accomplished what the Corps, after expending $2,500,000, had given up as impossible.

It may be true that the cut in the Red River dam was not an after-thought, as Colonel King states, but if so it would be very interesting to know why so much money was expended on a structure that was to be demolished before being entirely completed.

The Corps of Engineers may not be responsible for the incompetency of the instructors at West Point as reported by the recent National Board of Visitors, yet as long as that institution remains a close corporation such as it now is, what better results can be expected? No one will dispute the fact, as stated by Colonel King, that the method of selecting cadets from the candidates for admission to West Point must necessarily send a class of students there of more than average ability. This being the case, the result is all the more startling; for if the individual members of the Corps are

men of more than average natural ability, why do not their works make a more favorable showing than those of civil-engineer graduates of technical institutions? This condition of affairs simply illustrates *the fact that it is not the incompetency of individual members of the Corps that has made that body so inefficient, but that the inefficient methods of the system have had a tendency to prevent the officers from becoming so trained that they can successfully handle the engineering works that have been placed in their charge.* There is a vast difference in the incentive for exertion on the part of an engineer, whether promotion depends on waiting for his friends to die or whether advancement must be the result of energy and success.

Civil engineering has made such great advances during the past century that no one engineer can hope to do more than thoroughly master one branch of the profession; but from some of the statements that emanate from the Corps one would infer that the officers of that body were walking encyclopedias of all that is known in the science.* It may be that the attempt to accomplish this feat is one of the causes of their failure. At least, no effort is made to assign young officers permanently to work for which they have a natural taste, nor to place important engineering projects in charge of experts. There is scarcely an exception to the rule that young officers are transferred from one class of work to another at intervals of one to three years without any regard to their special qualifications.

The result of such practice is well exemplified by their work on the Washington aqueduct tunnel, where, after expending over a million dollars on work estimated to cost $545,031, it was found that nearly another million would be required to complete the work; and that when this was done, it would be exceedingly questionable whether it would be serviceable. The character of the construction put in under the supervision of the officers in charge of this project, and which they testified they supposed was good work, was such that 27,000,000 gallons of water would have percolated through the tunnel walls every twenty-four hours when subject to pressure in active service—an amount sufficient to have flooded the district and ruined the buildings along the line of the tunnel wherever this water found an opening for escape at the surface.

The committee of distinguished Senators who investigated this stupendous blunder say in regard to the manner in which the con-

* *Marine Review*, January 14, 1892.

tract was let : "It will be seen from the report of the engineer that he adopted a variable standard for determining which was the lowest bid, a standard that would enable him, as well as the Chief of Engineers and the Secretary of War, who were to pass on the recommendations, to give the contract to any one of the bidders preferred." As a matter of fact, this investigation showed that the contract was not given to the lowest bidder. This same pernicious system is still in vogue.

During the past year a contract was let by the Corps, involving the expenditure of several million dollars, in which independent bids were called for on three different grades of rock for doing the work, but of which a combination was to be used. By simply changing the quantity of the various grades, either of three different bids could be made to appear to be the lowest. The quality of sandstone rock to be used was specified, and it was distinctly stated by the engineer officer in charge that no variation from this standard would be allowed. The grade specified was one which was well known to be almost impossible to obtain within hundreds of miles of where the work was to be done, and consequently added materially to the amounts of the various bids. Late telegrams from Washington now state that this standard has been modified by the Engineer Department and a much lower grade of rock is to be accepted for the same compensation. This is rank injustice to the other bidders, and is but another phase of the question raised by Mr. Leicester Allen in his admirable paper on "Rights of the Lowest Bidder" in the January number of this magazine.

Major Ludlow says in regard to the Corps that "its record for eighty years has been that, expending some two hundred millions of Government funds, the United States has yet to lose the first dollar from malfeasance of any engineer officer." The public is not interested to any great extent in the shortcomings of any particular member of any great public body, so long as the safeguards against dishonesty are such that no great defalcation can occur; but this boast of superior integrity has been so often made that it may be well to state that the financial record of the Corps does not show that its members are any less liable to go astray than ordinary mortals.

It is well-known that the names of personal servants of officers sometimes appear on official pay-rolls as laborers on public works; that public property is sometimes sold without any return of the funds being made as required by law; and that vouchers for the

disbursement of funds are sometimes signed in blank and afterwards filled out in the Engineer's office.

I am confident that nine out of every ten officers who commit such unlawful acts do not do so from any motives of personal gain. In the successful prosecution of work under his charge an officer sometimes finds it necessary to have certain service or certain material that the department officer, ignorant of the necessities of the case, declines to approve of. The question then is, shall work be delayed and perhaps subjected to damage and loss, or shall an unlawful act be committed? I am sorry to say that the latter course is too often taken. A system that admits of such acts, or perhaps it may be said, requires them, cannot be condemned too strongly, for no matter how praiseworthy the motives may be the ultimate result if made public must be disgrace. An officer of the Corps is now being tried by court-martial at Cleveland on charges somewhat similar to the above, the result of which, whether acquittal or conviction, will undoubted have a beneficial effect with those of his brother officers who know only too well how to sympathize with the misfortunes of the accused. In fact I am reliably informed that orders have been promulgated already for a better accounting for of Government property in some of the Engineer offices.

It has been pretty well demonstrated, however, that the mutual-protection lines of the Corps have been so firmly drawn that no documents reflecting on the official actions of its members can be had from the office of the Chief of Engineers except by a direct order from Congress.

The cumbersome methods of conducting the financial business of the Engineer Department are such that a large portion of the time of officers is taken up in adjusting accounts and paying bills, instead of being devoted to the study of the engineering problems under their charge, and devising labor-saving methods by which the cost may be materially lessened. In other words, they may save a few dollars as disbursing officers, and waste thousands by not thoroughly understanding the necessities of the works under their direction.

Colonel King is perfectly correct in stating that it is commendable for an officer to listen to the opinions of his assistants, and to adopt them if of value; but for an officer, ignorant of the detail of the work of which he has charge, to palm off such opinions as original makes the whole affair a humiliating farce.

To refute the general denial made to the charge that officers

make statements before committees in Congress that the facts will not warrant, it will suffice to quote from a speech of one of the most distinguished Representatives in Congress: "And yet these gentlemen, who are our presumed hope, guides and support, the ones that a suffering commerce and a languishing State all look to, they come and certify these things to us as if we would never look up their past reports, but would go on and on, suffering forever, and forever sustaining them with the people's millions in wretched experiments that the great marine engineers of the world tell us are but child's play. It is in vain for these gentlemen to talk about this as a mere personal question, when the commerce of the country is suffering, *when they are failing in argument, failing in works and even failing in statements* of *facts*. I have been astounded at these proceedings."*

When a corps of men who pride themselves on their honor and integrity allow statements like the above to go unquestioned, comment is unnecessary.

I am somewhat surprised that a reference should have been made to the discussion in the Transactions of the American Society of Civil Engineers for 1886, in defense of the blunders that have been committed at Galveston harbor. The condemnation of the Corps in this discussion was of such a sweeping and convincing character that "silence" has been their watch-word ever since.

As to the excessive width between the proposed jetties for Galveston harbor, which the Corps claims is necessary to cause the ebb tide to do the scouring, it will be sufficient to refer to Mr. Ripley's admirable paper on Tidal Phenomena, in the Transactions of the American Society of Civil Engineers for November, 1891, where he shows: "The conclusion is irresistible that the building of jetties at Galveston harbor 7000 feet apart, with the expectation that the scouring force developed between them would be about as great as it would be were they placed half that distance apart, must be an error of judgment."

The Mississippi River Commission is made up of three West Point officers, one lawyer, two civil engineers and one assistant from the United States Coast Survey. It is provided in the bill that created the Commission that its President shall be an army officer, as also the executive officer and engineers in charge of the different districts. If this does not constitute a good working majority it will be hard to form one.

* *Congressional Record*, February, 1885.

The question is asked: "Is it likely that our eminent civil engineers, who generally find good salaries and plenty to do in private life, would sacrifice their independence and become government employés under the much ridiculed red-tape system?" This is the very point the members of the Corps should have considered long ago, and taken the steps necessary to modify the system of doing business so that a man of ability would not have to sacrifice his manhood and independence in order to be a member of that body.

On page 1348 of the Chief of Engineers' Report for 1881 is a statement that a contract for brush mattress work in place had been let for the construction of jetties at the mouth of the Brazos River at $6.75 per cubic yard. This work was continued under the direction of the Engineer Corps until 1887, when all of the jetties thus far constructed having either washed away or sunk in the sands of the gulf, the project was officially abandoned by the Corps as impracticable. Since then private enterprise has made this the deepest port on the Texas coast; and the writer, while chief engineer in charge of the harbor improvement and jetty work there, found that the average cost of brush mattress work in place, including superintendence, engineering and office expenses, was only $1.10 per cubic yard—or less than one-sixth of that done by the Government. The material in both cases was obtained from the same locality, and the cost of labor per day was approximately the same. In the work near shore, where the circumstances were similar to those under which the Government work was done, the cost per cubic yard of the private work was less than *one-tenth* of that done under the direction of the Engineer Corps.

A distinguished Army Engineer recently stated before a committee in Congress that: "The original estimate for the improvement of St. Mary's River was $2,600,000. Subsequently it had been increased to $3,100,000, but he was able now to state that by adopting the contract system the work would be completed within the amount of the original estimate." It is fair to presume that the contractors did not bid on less than an estimated profit of 20 per cent. of the contract price, and consequently the actual cost of this work under civilian superintendence will be at least $1,000,000 less than it would have been if executed under the direct supervision of the Engineer Corps. If these references are not sufficient to show the relative cost of work done by the Corps and by civilians, additional examples will be furnished on application.

Major Ludlow says: "None of the great undertakings entrusted to them has yet been shown as an actual or probable failure, and against the possibility of such in a few instances, must be set the hundreds and even thousands of cases where success has been complete and satisfactory." It must be that this officer has not read the annual reports of his chief carefully, or the numerous cases of failure there chronicled would not have escaped his memory. As a matter of reference a few of the more prominent instances are here given:

The original estimate for the Washington aqueduct tunnel was $545,031.41. After expending appropriations amounting to $1,354,534 on this project, *it was abandoned as not worth completing.*

At Charleston harbor, after expending $403,000 more than the original estimated cost of the improvement, they find that it will require $1,332,000 more to complete the work than the amount they stated would be required before anything was done.

At Manasquan River, $39,000 has been expended on the improvement of the harbor entrance, and the *last river-and-harbor bill contains an appropriation for removing the obstruction caused by this so-called improvement.*

At the mouth of the Mississippi River, $2,541,000 was expended in fruitless attempts to open a channel between deep water in the river and the gulf, and the work was abandoned, with a recommendation to cut a canal as the only hope of obtaining a suitable outlet. The undertaking was then given in charge of civil engineers, who in four years' time opened a permanent thirty-foot channel between the river and gulf.

At St. John's River, $937,000 have been expended on improvements originally estimated to cost $1,306,409, without producing any material changes for the better in the conditions existing there.

At Sabine Pass, $1,418,000 has been expended in obtaining an increase of three feet in depth on the bar, and the results thus far obtained indicate that to be the maximum that can be expected from the present plans.

At Galveston, they have had the use of $3,478,000—one and one-half million of which it is admitted was wasted in "tentative engineering"—and the almost unanimous opinion of hydraulic engineers is that no better results will be obtained with the balance.

At Brazos River, Texas, $158,750 was expended in an attempt to improve the entrance, and the work was then abandoned as abso-

lutely impracticable. Civil engineers have since made this the deepest port on the Texas coast.

At Pass Cavallo, $327,500 has been expended on work of which nothing remains. The project has been abandoned.

At Aransas Pass, the expenditure of $581,250 resulted in diminishing the normal width of the pass from 3100 to 1300 feet, and the project was then abandoned.

At Brazos Santiago, no results were obtained from appropriations amounting to $253,500, and all the works constructed are practically obliterated.

Mr. Barnum said in reference to his great moral show that "the American people liked to be humbugged and were willing to pay for it." The above examples, involving more than $13,000,000, would indicate that this saying is also applicable to the manner in which the public works of the country have been conducted by the United States Engineer Corps. Expressions of dissatisfaction, however, are becoming very general in regard to the management of the great enterprises entrusted to their direction, and it is very evident that a change of programme must soon be ordered or else the combination must retire from business.

# THE FUTURE OF THE TELEPHONE INDUSTRY.

*By Herbert Laws Webb.*

MANY people, and especially those people who write for the newspapers, like to speculate on the changes which will occur in the telephone industry when the fundamental patents owned by the American Bell Telephone Company shall have expired. These speculations are usually very wide of the mark, and, like most of the speculations indulged in by the general public guided by the intelligent writings of the omniscient newspaper reporter, are generally characterized by supreme ignorance of the subject in hand. The fundamental patents referred to are those which control the Bell telephone proper, now generally known as the "receiver," and the transmission of speech by means of undulatory currents of electricity.

It appears to be the general belief that when these patents no longer exist, when the public has the free right to make, install and use the Bell telephone and to transmit speech by means of undulatory currents of electricity, that the mainstay of the business controlled by the American Bell Telephone Company will have disappeared, and that what the newspapers love to term the "grinding monopoly" will be robbed of its powers to grind and to monopolize. The extraordinary sensation which the newspapers managed to evolve from the tardy issuance of the Berliner transmitter patent has lent considerable color to this view.

In holding to such a belief the public and the newspapers have stood still for about twelve or fifteen years. If, say, in 1880, or even a few years later, these two patents had been given to the public, the telephone company would have been robbed of its stock in trade; but to assume that at this date, or rather two years hence, when the second of the two patents will expire, the same conditions can hold good is to shut one's eyes entirely to the real facts of the case. If a young firm were to start out in business with a very small capital, its business might easily be ruined in the early stages by the withdrawal of that capital; but if the firm prospered and in the course of ten or twelve years built up an enormous business with widespread connections and a large market for its wares, any man of affairs would smile at the idea of such a firm

being seriously hampered in its operations by having to refund the original small amount of capital that enabled it to begin its business career.

The American Bell Telephone Company started out with a very insignificant capital, in the form of a few patents to which nobody but a few wise and discerning spirits attached any particular value. Of course there were discerning spirits on each side, among those who held the patents and among those who wanted them or thought that they had a right to them, and a fight for their possession ensued. By and by the knowledge spread abroad that the patents formed the corner stone of an industry of great commercial importance, and the fight waxed hotter and fiercer. How the contest was eventually decided is a matter of history and needs no repetition or comment. The telephone company vindicated its right to the possession of the patents and proceeded to build up a vast and powerful industry. The fundamental patents were the nucleus and foundation of this industry, but they no longer hold the same important relation to it that they did in former years. They do not form the key-stone of the telephonic arch, as the public and the newspapers appear to believe that they do.

The expiration of these patents will undoubtedly have a certain effect on the telephone industry, at any rate on some branches of it, which will redound to the benefit of the public. On the principal branch of that industry—the supply of telephone service in large cities—it will have very little effect, if any. If the public looks for competing systems in large cities in the course of the next few years, it is moderately certain that the public will be disappointed. It does not need a very deep analysis of the telephone industry to prove this, as will presently be shown. On the other hand, what is known as the private-line business will receive a marked impetus. At present all private lines and all telephone instruments used in buildings, private and public, are rented from the telephone companies; but with the expiration of the fundamental patents, the telephone proper and the right to use it will become public property. Telephones are not expensive to manufacture nor difficult to install, and there is no reason why private telephones should not very soon become as common as electric bells.

The telephone industry proper, *i. e.*, that of supplying telephone service in large cities, is quite a different matter. It is an industry that has been built up laboriously, step by step and year by year,

upon the slender foundation of the Bell telephone, which now forms a comparatively insignificant item of the total equipment of a large telephone system. It is an integral part of the equipment, of course, but the importance of its position has dwindled until it occupies that of a mere accessory in a vast and complicated organization of apparatus. All this apparatus, the product of years of invention, research and experience, is protected by patents which belong to the telephone interests; much of it is indispensable to the efficient operation of large telephone exchanges. The equipment of these large exchanges and the construction of the general plant of a large telephonic system have been a work of slow growth, carried out under continually changing conditions and at an enormous cost. A telephone exchange to-day is something entirely different from a telephone exchange of five years ago; it would be safe to mark a shorter period of transition and to say three or four years, but it is generally held in telephone work that the plant undergoes almost a complete change in every five years.

We are generally informed through the newspapers that the telephone companies suppress the improvements that are continually introduced in the apparatus used by them. Like much of the information disseminated through the same channels this is entirely untrue. During the past few years so many improvements and modifications have been made in every detail of the equipment of telephone exchanges that they amount practically to a complete remodelling of the system, while the extensive introduction of underground wires has wrought a radical change in telephone engineering and has necessitated the designing and erection of special telephone buildings, of which there are now four in New York City alone. In having forced on it these constant changes and rapid revolutions in its plant, involving large expenditures of capital, the telephone company stands quite alone among the corporate servants of the public; for it must be borne in mind that such changes are not solely accounted for by additional business nor absolutely rendered necessary by the increase in the number of subscribers, but are brought about by the introduction of improvements in methods and apparatus, which, by increasing the efficiency of the service, render it more valuable and place the telephone exchange industry on a firmer basis. There is no other public service which is liable to the upheavals that occur in the telephone business and there is none that is the object of such constant modification and improvement.

In all large cities the established telephone companies now hold positions from which they can practically defy competition. In the foregoing paragraphs the peculiar nature of plant of a large telephone system is briefly referred to. The great complexity and enormous cost of such a plant and the skilled organization necessary to maintain it in a state of efficiency are points that are properly appreciated only by those familiar with the telephone business. But there are other features of the telephone systems of large cities discouraging to competition which can be understood readily by any business man. The network of existing wires is one of these. Overhead wires in large cities have seen their day, and the municipal edict has gone forth that only underground wires must be used in future. Some overhead wires still exist, but on sufferance only, and additions to their number would not be tolerated. To put down underground wires on a large scale is a very serious and costly undertaking ; for telephone purposes it is impracticable to put them down on a small scale. They cannot be run wire by wire in the same manner as overhead work, a wire being run here and there as needed and led off in any given direction ; the distribution must be planned out carefully beforehand, as the main routes must be served by heavy cables containing large numbers of wires all of which have to be terminated at and distributed from certain fixed points. It is readily conceivable, therefore, taking into consideration the additional difficulties of the subways, roof privileges and way leaves, that an underground system of telephone wires is not a question to be attacked lightly ; in fact, such a system is only applicable and its cost only bearable where the number of subscribers is very large. With a small number to start with it would prove an almost insuperable obstacle unless a very large amount of capital were willing to lie idle and await developments.

It would be practically impossible for a new company to offer its patrons, or those whom it might approach with a view to their becoming patrons, anything like the facilities which the existing companies place at the disposal of their subscribers. It may be urged that the major part of the business of any one subscriber is transacted with a comparatively limited group of other subscribers, and that if communication with these is provided that is all he wants, and a cheaper rate would induce him to change over to a new system provided that his correspondents also signified their intention of doing so. Such an argument soon falls to the ground, because it will be found that such groups run into each other and

overlap, as it were, to a very great extent. To many subscribers, also, it is of great importance to obtain connections with suburban and long distance points, and to others the fact that they can call up or be called up by any one of eight or ten thousand other subscribers is a weighty consideration. It is pretty plain, therefore, that at this date the starting of a new telephone system in a large city, beginning operations on a small scale, would be an altogether unprofitable and hopeless undertaking.

Looking at such an enterprise from another point of view, it may be asked what would be the chances of a company with a large capital prepared to begin operations on such a scale as to embrace every part of the city and provide communication wherever it might be called for? Such a company would labor under very great disadvantages; the outlay of capital in order to properly provide for the demands which might be made on its system would have to be enormous. Years would elapse probably before sufficient subscribers could be obtained to pay even the working expenses, and in that time much of the plant would become obsolete almost before it had rendered any service. Such a company, instead of building up its plant and gaining its experience gradually with the growth of the business, as the existing companies have done, would have to begin business with a complex piece of machinery which for its efficient maintenance needs the most thorough organization of skilled workers, and would of necessity make many mistakes—and there are few industries in which mistakes cost more money than in the operation of a large telephone system.

From every point of view from which the subject may be regarded only one conclusion can be reached, and that is that the expiration of the telephone patents will have little or no effect on the telephone-exchange business in large cities. Competition is practically impossible because of the various reasons stated, which may be summed up as follows: The established companies occupy the ground in such a thorough manner that there is no room for new-comers. The plant required is so expensive and complex, and the probable returns would be so slow, that capital would not be easily tempted. The underground-wire question offers such serious obstacles as to still further discourage capital. The nature of the business is so peculiar and so little understood by those not actually engaged in it that the economical management of a large system could not be successfully carried on by untrained hands.

It may be here mentioned that the only instance of a competing

telephone exchange system in a large city, started on the strength of the expiration of the telephone patent, has not been a successful venture. The receiver patent expired in Great Britain in December, 1890. Shortly afterward the Mutual Telephone Company began business in Manchester, and, through the inducements of a very low rate and co-operative sharing of profits (*i. e.*, the promise of such sharing), secured several hundred subscribers. Before very long it was found that the business did not pay, and the Mutual amalgamated with the established company some time last fall. In Canada, the Bell patents were lost owing to failure to comply with the Canadian patent law, and for a long time there were two competing telephone systems in Montreal. These companies also amalgamated last year and the rates were raised. It must be borne in mind that both in Manchester and in Montreal overhead wires are used. In London much dissatisfaction has long been openly expressed with the telephone service, and there has lately been some talk of founding a new company with a very large capital. London, however, is a very large city, and telephonically is very badly off, as it has fewer subscribers than New York, with five times the population. There is probably room, therefore, for a new company which shall offer an improved service, although such a company will find the work of establishing a footing by no means an easy task.

It will doubtless be felt by most telephone subscribers that even if the expiration of the telephone patents does not give rise to competition which might or might not be of benefit to them, it should at least result in a reduction of the present rates. It is more than questionable, however, whether such a reduction will be effected. The reader has understood already that the telephone receiver, on which the patent will expire, is a comparatively small part of the equipment of a large telephone system. The rental which a telephone company pays to the parent corporation for the use of a receiver is but a small item of its total yearly outlay. If this rental, amounting to seven dollars a year, were deducted from the rate paid by the subscriber, that individual would consider the reduction of fifty-eight cents a month in his bill a very insignificant favor, but at the best that is all that he can have any right to expect at the expiration of the patent. It must be borne in mind, however, that the telephone subscriber of to-day gets very much more for his money than he did a few years ago. Improved apparatus, underground wires, advanced engineering, more skilled super-

vision have resulted in vastly increasing the efficiency of the service and in lessening the frequency of interruptions; while extensions of the system and the building of improved trunk lines to suburban and long distance points have greatly added to the facilities at the subscriber's disposal. All this work costs money—the cost of the extensive use of underground wires, of which there are upwards of 30,000 miles in New York City alone, far more than offsets the saving that will accrue to the telephone companies at the expiration of the patents—and the telephone subscriber of to-day gets fair value for his rental.

Although it is perfectly evident that in large cities no particular change will result from the expiration of the telephone patents so far as the exchange business proper is concerned, yet in the private line business, both in cities and throughout the country, the effect of free telephones undoubtedly will be felt very largely. Large corporations who rent private lines running to a dozen or more different points scattered all over a city and its suburbs will perhaps not be benefitted very much. They contract with the telephone companies for the installation and maintenance of their lines and save themselves all further trouble; the telephone company offers them certain facilities, as it has its wires established and running to all points and its staff organized and available for the work of installation, inspection and repair at a moment's notice. Such facilities as these are an important consideration where long lines are concerned and prompt service is the first desideratum. This class of private-line business will in all probability remain with the telephone companies. But there is a very large class of private-telephone business only partially developed, on account of the expense which a private telephone line, however short, now entails, that will in future be carried out by electrical contractors and even by the individuals who require communication themselves, for there is nothing electrical simpler to install and maintain than a short-distance, two-station telephone line.

When the telephone is a free article of manufacture it will not take long for telephones to be as common as electric bells. Many who now do without them on account of the expense and trouble entailed by renting instruments will then install their own private lines for all purposes. When one considers the many applications entirely apart from general exchange service of which the telephone is capable, from providing communication between the different departments of the ordinary private house up to complete

systems for large factories and private lines between different establishments, it is evident that there is an immense field open for cheap telephones. It may be argued that only the receiver, or Bell telephone, will be free for the present, and that the carbon transmitter, considered essential to efficient telephonic transmission, will still be protected by patents. That is a vexed question which it is unnecessary to discuss here, because it is a fact, although few people seem to be aware of it, that the Bell or magneto telephone is a remarkably efficient transmitter for short distance work. Of course, nobody would attempt to carry on conversation between New York and Boston with magneto telephones, but with a well-built line they will give quite satisfactory transmission between points several miles apart. I have talked with perfect ease over a circuit made up of about nine miles of submarine cable, using only ordinary single-pole Bell receivers. The Mutual Telephone Company, which began business in Manchester, England, some time before the British microphone patents expired, equipped all its subscribers' stations with magneto transmitters of a special design, and the service gave no cause for complaint. Therefore for the great bulk of private line work the carbon transmitter may be entirely dispensed with.

The natural inquiry arises, what will telephones cost when their manufacture is free, and what will be the expense of equipping a private line? It is scarcely necessary to go into detailed estimates at this juncture, especially as the cost must necessarily vary with the conditions, such as the class of work required, the finish of the instruments and so on. A telephone that will speak can be made for very little, and small instruments for household work need cost no more than electric bells of the same quality and finish. Some years ago I put in a large hotel in Spain an installation of electric bells and telephones; the telephones were in the form of ordinary push-buttons; you pressed the button and then pulled the wooden case from the clamp which held it to the base fixed to the wall and spoke into the back of the push, which contained a telephone of the ordinary Bell pattern with a very short magnet. The cost of these instruments was very small. I do not recollect the exact price, but it was less than a dollar, and they gave excellent service; the women servants in the hotel used them readily from the very first. This incident is mentioned merely to show how cheap and how simple is the application of the telephone to household use.

For more serious purposes a more complete outfit would of

course be required, but it need by no means be a costly one. Most people who are accustomed to using the telephone would find it inconvenient to use the same instrument for both transmitter and receiver, and would prefer to have them separate. A complete outfit, comprising magneto bell, transmitter and receiver, could be made by any electrical manufacturer for about six or seven dollars and competition would probably soon reduce the price to an even lower figure. Such a set would require no battery, and with fair usage would never get out of order, costing nothing for inspection and maintenance. The cost of building lines of course necessarily varies in different localities and according to whether a single wire or metallic circuit be required or a house-top or a pole-line; in any case, however, the cost of such work is not excessive, and the conditions being known, any electrical contractor can prepare a sufficiently close estimate.

It is sufficiently obvious that the expiration of the fundamental telephone patents will not alter the conditions of the telephone industry in large cities, where, for the various reasons pointed out, it is established in an unassailable position; but it will affect very largely the private-line business and will develop the general use of the telephone in all walks of life to a very great extent. The telephone is the simplest of all commercially useful electrical apparatus; it can be cheaply constructed and easily installed and maintained in working order, and it unquestionably has a great future before it.

# THE MANUFACTURE OF ICE.

*By Leicester Allen, A. B., M. E.*

I HAVE never seen any person of inquiring mind, not acquainted with the principles of refrigeration, who upon first sight of a modern ice-machine did not express wonder at its operation and wish that he could comprehend its apparently paradoxical performance. Here is, for instance, a furnace producing intense heat at a rapid rate. In relation with the furnace is a steam boiler, the steam from which passes into the cylinder of a steam-engine forming part of an ice-machine. A powerful compression pump driven by the steam-engine also forms part of the machine, and these two elements—the steam-engine and the compression pump—with their appurtenances, constitute the whole of the moving machine. One feels heat in both the steam-engine and the pump ; * but a little way, or even a long way, from the machine the astonished beholder sees sometimes miles of iron pipe loaded with ice and snow, huge vaults or chambers glistening in arctic splendor, or enormous tanks filled with ponderous cakes of clear and beautiful ice ; and all this, perhaps, in the dog-days, the thermometer noting an exterior temperature of ninety degrees, and in the boiler room, where coal, the primal source of all this wonderful transformation is being consumed, perhaps marking a hundred degrees and upward.

The writer once placed a small ice-tank on a steamer within one foot of the range in the ship's galley. The heat of the range near the ice-tank would easily blister the hand. A lady seeing cakes of ice, champagne frappé, frozen grated pine-apple and ice-cream taken from this tank when the temperature in the galley was at least 100° F., said : " Heat melts ice, and yet you say you make ice by using the heat of burning coal ; to me the two statements appear contradictory, unless indeed you are a performer of miracles, or a magician." The champagne and ices were however solid facts—occasionally too solid, since, through the carelessness of the steward, many bottles of bright and effervescent liquid were burst that summer by being left overlong in the tank. In the boiler-room where the ice-machine was delivering air at a tempera-

* There are some exceptions to this. The pump-heads of some ice-machines do not feel hot to the hand, owing to the low temperature at which gas is inducted to them.

ture of −40° F. the temperature was not infrequently 120° F. The locations, both for the machine and the freezing tank, were not such as would be voluntarily selected; but they were the only ones to be had on that ship. Some of the seamen expressed their belief that they might each have been put inside the boiler-furnace, since, in their opinion, the thing would make ice in a much hotter place, the name of which is considered by rigid moralists as a too frequent expletive among seamen.

Many modes of making ice are known, and many substances, exclusive of fuel and water, for supplying mechanical power, and brine (only employed as an extractor and conveyor of heat) have been more or less used. Among these materials may be named ammonia, ordinary atmospheric air, ether, cymogene, sulphur dioxide, first used by Pictet; a mixture of ether and sulphur dioxide, introduced by Tessie du Motay; carbonic acid, and mixture of carbonic acid with sulphur dioxide, etc. In the evolution of the art of artificial refrigeration and the survival of the fittest, only two materials out of all this category remain in use to such an extent that they need be mentioned in this article. These substances are common air and ammonia, the latter having almost wholly superseded air in ice-machine practice, except for cooling on sea-going vessels and a few special purposes on land. And all refrigerating processes, employing air or ammonia as stated, may be grouped under three heads—those depending principally upon chemical affinity for the production of a condition in ammonia that will fit it for the production of cold; those in which the action is wholly mechanical, and those in which ammonia is acted upon both chemically and mechanically.

The difficulty attending a popular exposition of the scientific principles underlying the action of ice machines can be appreciated properly only by those who have laboriously plodded through abstruse treatises on thermodynamics; and as only by mathematical methods can an exact and thorough knowledge of the subject be attained, I shall herein only attempt a statement of some of the most easily comprehended principles.

The action of ice machines, and their connected apparatus is, in most particulars, entirely different from that of an ice-cream freezer. In this common domestic apparatus, ice is consumed to form ice in the cream vessel, so that, at the end of the process, there can never be in the freezer any more ice than at the beginning; owing to unavoidable waste there is always somewhat less. Ice ma-

chines, on the contrary, start off with no ice at all and constantly turn out in regular succession large blocks of ice ; or, if actual ice is not desired, they are used to cool a large room, or a mass of material stored in an enclosure to any temperature above the point of freezing.

Now, many gaseous substances need only to be compressed at ordinary temperatures to change them to liquids. In fact nearly all known gases have been liquefied, but there are some, as anhydrous ammonia, sulphur dioxide, etc., that, while liquefying under easily managed pressures, not only set free a large quantity of latent heat when liquefied, but which, if the heat thus set free be taken away, will, when the pressure is removed, again turn to gas, and reabsorb (render latent) as much heat as they gave off in liquefying, from any contiguous body having a higher temperature. If no such body be near, they still vaporize, rendering latent a part of their own sensible heat. The absorption of their sensible heat, of course lowers their temperature, and they thus become intensely cold. They are thus brought into a condition for extracting heat from any other substance having a higher temperature.

We are now nearly prepared for the analysis in a general way of the operation of a compression ammonia ice-machine, but before we can attempt this with success, another principle claims attention. From the experiments, first of Count Rumford, and after him, from the mathematical and experimental researches of many others, culminating in the triumphant labors of Joule, it has been completely proved, not only that the compression of a gas imparts heat to it, but that the heat so imparted is always the exact measure of the work performed in the act of compression. Further, these investigators have proved that the converse is also true. The gas when it expands again performs work while losing heat, and the work so performed is the exact measure of the heat so lost.

The essential parts of a compression ammonia ice-machine are, a compressing pump ; a motor, usually a steam-engine that drives the compressor ; a cooling receiver, usually a system of pipes connected with the pump and placed in a tank of water kept by constant inflow and outflow at nearly the ordinary temperature ; a tank containing strong brine, and also a system of pipes connected both with the receiver and the inlet valves of the pump, into which pipes the liquefied ammonia is allowed to expand as regulated by a valve, and from which the pump constantly takes out ammonia gas to pass it again into the receiver.

The pump so inducting the gas presses it into the receiver, the valve that regulates expansion into the pipes in the brine-tank being adjusted to maintain a proper pressure in the receiver, and this pressure being such as will cause the ammonia to liquefy at the temperature of the water surrounding the pipes in the receiver. In liquefying, the vapor yields up its latent heat to the water surrounding the pipes in the receiver. In again vaporizing in the pipes of the ice-tank into which it flows, the gas first absorbs enough of its own sensible heat to bring it slightly below the temperature of the brine in the tank, and, thereafter, all the latent heat required to vaporize it is taken from the brine.

In this brine (a solution of common salt, chloride of magnesium or similar salt, that freezes only at temperatures much below the freezing point of water) molds filled with either filtered or distilled water, or both, are placed, and to this cold brine the latent heat from the freezing water passes till the water is frozen. The molds are then lifted out and placed in a tank of warm water till the ice loosens from the molds, when the blocks of ice, clear as plate glass and much purer than most natural ice, readily slip out and are ready for market.

If, instead of a brine-tank, an inclosure, such as a storage-room for meats or other perishable substances, is required to be cooled, pipes corresponding to those in the ice-tank are placed directly in the space to be cooled, and the ammonia may be allowed to expand directly into them. In most cases, however, it is preferable, for various reasons, to first cool brine precisely as it is cooled in the ice-tank and circulate it by pumping through a system of pipes in such rooms.

In modern ammonia ice-machines, cooling the expanding gas by performing work with it has been abandoned, because the additional effect gained by this is so small, as compared with the cooling effected by the absorption of latent heat, that the gain does not compensate for the additional complication of machinery necessary to secure it. On the other hand, in cold-air machines that cool air through alternate compression and expansion of air, the air is not liquefied under compression, there is no absorption of latent heat from it, and the entire action of such machines is mechanical. Work is first performed on the air to compress it, by a steam engine. The heat equivalent of this work is then extracted by cooling the air under constant pressure by water at ordinary temperatures; the air so cooled is inducted to a compressed-air engine that assists the

steam-engine in the work of compression, and the air exhausted from the air-engine is thus reduced in temperature by the conversion into work of the heat equivalent of the work performed. Temperatures of from –60° to –80° F. in the air so exhausted are thus readily attained. This cold air may then be either discharged broadcast into a room to be cooled, or it may be conducted through a system of pipes in an ice-tank or cold-storage room in a manner precisely analogous to that described for the compression ammonia machine.

This class of machines is in favor for marine use, for transporting meats, etc., and for ships of war, on account of compactness and convenience for ship use. The economy of fuel is not in any way comparable to that attained in ammonia machines. In the best types of the latter, ice of the finest quality is claimed to be produced under favorable conditions for from $0.75 to $1.25 per ton, according to varying circumstances attending its production, while the cold-air machines are only used for making ice, on a small scale, in connection with cold storage, water cooling, etc., and not for the commercial production of ice.

The absorption ammonia machines operate as follows : A strong solution of ammonia in water is used instead of pure ammonia gas. This solution, being heated in a boiler, gives off the gas of ammonia together with some water vapor. These are passed through an apparatus that separates the water and leaves the ammonia as nearly as possible anhydrous ; but hot, and still under a high pressure. The gas then passes to a cooling receiver and still under pressure is condensed to a liquid. Thereafter all the operations are the same as for a compression ammonia machine, except that the gassified ammonia, instead of being compressed and pumped from the ice-tank directly into the receiver, is passed into a receptacle called the absorber, that takes the place of the compressing pump. To this absorber the water previously separated from the gas is constantly supplied, having been cooled in its passage, and the strong chemical affinity between cool water and ammonia gas, previously overcome by heat in the boiler, again unites them. The compression of the gas, thus accomplished chemically, causes it to part with its latent heat. This, together with the heat due to the chemical compression of the gas, must be constantly extracted by cooling, else the ammonia solution in the absorber would remain too weak for the effective generation of gassified ammonia when returned to the boiler, or "*generator*" as it is commonly called.

The water charged heavily with the ammonia is again pumped into the boiler. All these operations are simultaneous and continuous in the several parts of the apparatus, for it is more properly an apparatus than a machine.

The successful introduction of ice machines and their extended adoption has all been accomplished since 1870. Before that date artificial refrigeration was confined to small absorption machines of the Carre type, and a few feeble cold-air machines, so ineffective that they are scarcely worth noticing. The Windhausen cold-air machine as modified in England and applied to the shipment of dead meat first strongly attracted inventors and scientists to the immense possibilities of this new field, and immediately all the knowledge that had been gained in modern research was brought to bear upon improvement. Most brilliant results have been achieved. No class of machinery requires a higher grade of engineering ability for successful construction than this. It involves the most thorough knowledge of thermodynamics, as well as of mechanics in all its departments; but this knowledge had been supplied, and the constructive skill existed. The outcome has been far-reaching in its effects in industry and commerce.

In brewing, no plant except for manufacturing ale and porter, is considered complete without two refrigerating machines, one to relieve the other when repairs, etc., are needed. In fermenting-rooms and storage-rooms for beer in breweries, the pipes, either containing the cold vapor of ammonia, or, as is now more generally practised, containing brine that has been made cold by circulation over ammonia pipes in a special tank for that purpose, are usually placed overhead, and the fermenting-tuns or storage casks are arranged below them. The process of fermentation generates heat in the tuns, and this being imparted to the surrounding air the latter rises to the pipes, is there made cold by contact with the pipes and descends to the floor again, where it surrounds and cools the tuns. In some cases, coils of pipes are placed directly in the fermenting-tuns. The air rising to the pipes overhead is not only cooled, but in being cooled, it deposits a portion of its moisture on the pipes. This moisture is instantly frozen, and after a short time the pipes become loaded with snow that, after a while, may assume the solidity of ice, the entire ceiling thus appearing as if supporting massive cylinders of ice, that reflect the light of a lamp, or a gas-burner, as do stalactites in a cave.

The capacity of a brewery as relates to out-put varies almost exactly as its storage capacity varies; and in the old method of cooling by natural ice, a very large space was occupied in the storage of the ice that now may be used for beer storage. Again, the quality of the beer and the certainty of securing a good fermentation depend very much upon the certainty of maintaining uniformly a lower temperature than can be maintained in torrid weather by the ordinary use of natural ice. With ice-machines the brewer can keep the temperature in the fermenting-tuns at the lowest point at which he wishes the fermentation to proceed, thus certainly preventing a class of fermentations that set in at higher temperatures to the great injury of the beer. Taking all these advantages into account, many brewers assert that they could not afford to go back to the old system of ice-cooling, could they get their supply of natural ice for nothing.

In the transportation of food, fresh meat from Australia and from American ranches is regularly supplied in prime condition to European markets. This meat, killed in large slaughter houses, is placed in enormous cooling rooms, and the animal heat is extracted from the carcasses as soon as possible. The meat is not generally actually frozen, but is brought down nearly or quite to the freezing temperature ; it is then transferred as quickly as practicable to an insulated room fitted up especially for the purpose on board the vessel which is to carry it, this room having been made previously cold by an ice machine on board the vessel, and driven by steam from the ship's boilers. The cold room in the slaughter house is generally cooled by an ammonia machine, the pipes being either placed overhead or, in some cases, attached to the sides of vertical posts, but at a considerable distance above the level of the floor. The cold room on board the ship, if cooled by a cold air machine, may or may not have pipes for cooling. Most of this kind of machines after mechanically cooling the air discharge it broadcast into the room to be cooled, at the same time forcing out of it an equal volume of air at the temperature of the room.

In the manufacture of mineral lubricating oils, ice-machines have become indispensable. To obtain oils that will not solidify in cold weather, oil as extracted from petroleum is frozen in suitable receptacles after a manner precisely analogous to the artificial freezing of ice ; that is to say, such parts of the oil (which is a mixture of various hydrocarbons having different freezing points) as will freeze are frozen. The congealed mass is then subjected in a cold room to

powerful pressure, which squeezes out the yet liquid portions, and as these portions will not freeze at the temperature of the press room, they are sold under special names to users requiring oils that will flow from oil cans at low temperatures. Some of these oils remain sufficiently fluid for lubricating purposes at remarkably low temperatures. I have used one kind specially supplied for the purpose in the cylinder of a cold-air machine delivering air at −80° F. At this temperature this oil had the consistency of butter. Most ordinary oils would have become as hard as beeswax under similar conditions.

In many chemical industries, as in the treatment of essential oils, in the extraction of their solid constituents, and in many other applications, the use of ice-machines is extending.

Last summer a large part of Washington market in New York City was refrigerated by an ice-machine, and a common sight was the delivery of machine-made ice, infinitely better in appearance than natural ice, and, being more compact in texture, much more lasting.

Mr. George W. Rafter's excellent paper, "Epidemics and Water Pollution," printed in this magazine for May, 1891, points so clearly to sources of disease in polluted water, that it may well be referred to in this connection. Another able enforcement of this lesson is contained in the article entitled "Impure Water and Public Health," from the pen of Floyd Davis, E. M., Ph. D., in the number for December, 1891. Mr. Davis speaks of decaying organic matter, and infections micro-organisms as one or the other, or both, to be found in much of the water supplied to cities for potable purposes. It may not be known to many, that many of these organisms survive the action of freezing, and that in ice cut from impure water the microscope detects them in an active state when the ice is melted, but such is the fact; and as regards organic impurities, the accumulation of dirt in refrigerators deposited from the ice placed in them is ocular evidence. In much of the natural ice supplied to families in cities, dirt may be seen in specks, and small aggregations and an examination of these deposits often proves them to consist of very disgusting putrid material. I have thus detected excrementitious matter, bits of decayed meat, and ooze from miasmatic marshes, and I have no doubt that natural ice is more often than is generally suspected, a vehicle for the conveyance of the germs of disease. The importance of the use of artificial ice made from purified water, as related to cleanliness and

sanitation, cannot, in my opinion, be too strongly emphasized.

By the use of such ice, not only is an unfailing supply insured, but immunity from germs of disease conveyed into potable water from filthy ponds and streams is secured.

Not many years will elapse before fever-wards in hospitals will be artificially cooled. There is no existing difficulty worthy of mention in making this application. The box coils that do the steam heating in cold weather can be used in summer for cooling without any important change in the heating and ventilating apparatus. It is only necessary to circulate through the coils a liquid previously cooled by an ice-machine and keep the fans going to blow air over the pipes and force the cooled air into and through the apartments to be cooled. In this way a ward might be kept at a temperature of 60° F. while the outside temperature might be 90° in the shade. The comfort and benefit of this fresh, cool, dry air to patients needs only to be indicated. In a similar way churches, theaters, museums, public libraries, legislative halls, court-rooms, etc., can be cooled and ventilated in hot weather, the air being made both wholesome and luxurious.

The preservation of bodies after death, as in morgues and undertakers establishments, may be accomplished by ice-machines.

Cold-air machines of modern type are now used on some of the United States war vessels, to the greater comfort of their crews and the more speedy healing of their sick or wounded. It is by no means improbable that the mechanical cooling of theaters, churches and other places of public assembly may yet be as regularly practised in summer, as they are now heated in winter.

The chapter of improvement in this line of engineering cannot be considered as completed till the cheap, easily-managed, domestic ice-machine, furnishing cheap ice to households, takes the place of the present domestic refrigerator. The writer has been offered large sums of money for the production of such an apparatus, provided it could be made to fill all the requirements of cheapness, ease in manipulation, durability and efficiency, and there is no doubt in the minds of any who have studied the problem, that the field for such an invention would be enormously wide and remunerative—a veritable gold mine. The difficulty is to meet the requirements. In their nature and in the nature of the use to which they must be put, an *apparatus* rather than a *machine* is indicated. Doubtless it will at some time make its appearance. The world waits for it.

# AMERICAN SUPREMACY IN APPLIED MECHANICS—IV.

*By Coleman Sellers, E. D.*

AMONG the great works of the last half century the public looks with the greatest feeling of wonder at the vast structures looming up in many places on the globe to facilitate locomotion, to mitigate the dangers of inundation, to effect the drainage of land—at the bridges, the towers, the vast reservoirs, capacious docks, mighty breakwaters, railroads and canals. The Eiffel tower is possible, however, only through and by the result of applied mechanics, and great as these engineering works are, conferring in many cases incalculable benefit on the human race, yet in the far-reaching benefit of the greatest of these, no one perhaps can compare to the service rendered to mankind by the mental effort of any one of the thousands of great inventors who have rendered these engineering works possible or even needful.

It has happened that the originator of these blessings may have been named Watt or Arkwright or Whitney or Bell, or in higher pure science, Sir Isaac Newton, Bacon, Franklin, Faraday. Yet each of one of these must have drawn inspiration from some higher and unknown source, from the first great cause of all that we see about us. The opportunity is presented and results follow in orderly sequence, the humblest laborer in some way helping in this progress in preparing the ground for the seed that is to germinate and bear fruit each after its kind. This it is that accounts for the simultaneous inventions of what will fill a want by men far removed from each other, each working in ignorance of the labors of the others.

In looking back over the history of those who have helped forward the great work of mechanical progress, we find continually the names of men who had but limited means to acquire knowledge. The fact that so much has been accomplished in applied mechanics by those who have had but limited chances for technical education does not prove that such education is not required. Each step taken in advance by those who have labored diligently and laboriously through long periods of experimentation makes further advance by new and inexperienced workers the more difficult unless they

can at schools and in shops take up the work where others have left off and through systems of education master the theory of what has been done. Each great discovery in applied mechanics starts others to work on the same line of thought. Whitney's cotton-gin was followed by a long list of patents each covering some novelty that of itself makes a claim for monopoly just; some may have been useful, others useless in practice.

In 1884 at the annual dinner of the Institute of Civil Engineers in London, Sir Lionel Playfair, in reply to one of the toasts, spoke of technical education and its importance and commented favorably upon what was being done in the United States in this direction as compared to the little that had been attempted in Great Britain, as the present school organized by the City and Guilds of London had not then been put in operation. More than one citizen of Great Britain has visited America to try to discover why certain machinery that had been taken from America to aid in some particular manufacturing enterprise had proved less efficient in Great Britain than it was said to have proved in the United States, and after seeing that the value of the machinery in the hands of the workmen in America had not been overstated, has made the assertion that the difference between success in one country and failure in the other was on account of differences in the habits and education of the workmen in the respective countries, assuming that this education had been beneficial to the people of the United States. It would extend these papers to too great a length to fully go into this subject, but it would be well to call attention to what may be gained by the teachings of these schools that were so highly complimented by Sir Lionel Playfair in 1884.

The American W. D. Ewart who patented a system of malleable-iron chain adapted to carrying power from one toothed or sprocket wheel to another was the first of about six hundred inventors who claimed improvement or modification on what he had begun, while no less than five hundred claimants for improved link transmission had their demands rejected by the Commissioner of Patents. This is but one instance of what follows a successful application of mechanics and is nothing compared to the story of wasted ingenuity expended in car-couplers by men who see utility in mere difference of method; who, ignorant of railroad wants, see success and fortune in devices that work in the model but are not adopted by those capable of judging relative merits.

It is difficult in a paper of this kind to do justice to all those

who have contributed to the supremacy of America in applied mechanics, and the mention of any name seems invidious, but in the case of the invention above mentioned of malleable-iron chain, it is selected as an illustration of one of those inventions seemingly so simple in the idea that has, contrary to what has often been the case, accrued to the benefit of the man who conceived the idea. For conception of an improvement to be followed by success in introduction and reasonable pecuniary return requires the exercise of faculties other than that of mere invention. It implies a knowledge of business methods, and it requires what we are all willing to claim as characteristic of the whole Anglo-Saxon race, and that is indomitable perseverance.

Technical schools are not to be expected to make mechanical engineers. They are expected to teach habits of correct thought, habits of correct method, to impress on the mind fundamental laws of mechanics, to teach correct business methods and habits of observation, not only as regards mechanical principles but as regards comparative cost in methods and minute observation of differences and the careful analysis of cause and effect. The history of progress is full of examples of able men following a wrong road from ascribing effects to what in the end has proved not to be the cause.

Those who expect the Stevens Institute and the Boston Institute of Technology, or the technical schools of the universities, to give instruction that will do away with the need of actual shop practice and experience gained afterward, will be disappointed. They will not be disappointed when they find those who are talented advancing with rapid strides when advance means more than it did twenty years ago. This statement is proved by the readiness with which able graduates of technical schools obtain positions and are appreciated by those who, no matter what may be their business capacity, lack just what the employés have obtained at school. Little by little these schools will improve as the alumni become matured. Each grateful to his alma mater and intent on advancement will suggest such changes as his experience teaches him to be essential, and alumni acting collectively will improve the methods of the schools.

Industrial schools in connection with our common-school system are now filling a long-felt want and are in the near future to impress upon parents the great advantage of mechanical training as tending to increase mental activity. After pushing education of

the head alone to an extreme it is time to turn attention to the training of the hand, that member of the human body which makes man the ruler, making him with his armed hands the superior of the most violent brute force and enabling him to tear down the mountain of minerals to gather the metals that are to serve his fellowmen.

Bearing upon our local industries and likely to exert a powerful influence on future progress came the rapid organization and perfection of manual-training schools in our chief cities. It is not sufficient that our children should be taught to read and write and be masters of language or even of the sciences, but it has been proved pre-eminently in America that the mind and hands can be trained at the same time and without prejudice to either. America in the organization of training schools of this kind has been far from slow in availing itself of what has been done in a similar direction in France, Germany, Russia and Sweden, but it has given a practical direction to the instruction that will for a long time make those who wish to advance this kind of education turn to America for models upon which to base their systems of education.

E. B. BIGELOW.*

The time has come for drawing to take its place with writing in the primary schools. The time has come, too, when every child shall be taught the true meaning of the correlation of forces and the conservation of energy, that they may grow up with the knowledge that there is only so much power in the universe and that the utilization of this power like the utilization of coal and metal and the fruits of the earth can only be accomplished by the expenditure of labor; that we can create no power, nor can we create new beds of coal, but we may economize what a bountiful Providence has given us and make each mental effort, like a pound of coal, yield a larger return of usefulness through a higher efficiency in our machines and in our methods.

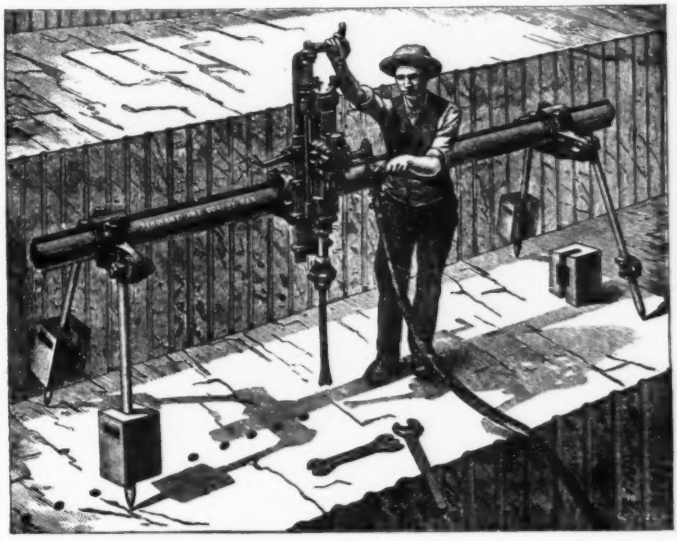
The United States, with no standing army, but with a nation capable of putting into the field many millions of good and effi-

*Erastus Brigham Bigelow, born in Massachusetts, 1814; died, 1879. His father was a cotton-weaver and as he was unfortunate the son, who desired a liberal education, turned his attention to inventing. At seventeen he made a hand-loom for suspender-webbing and a piping cord machine. In 1838 he invented an automatic counterpane-weaving loom, and one for coach lace. In 1839 he patented the power carpet-loom, which he brought to high perfection.

cient soldiers when the time comes for their work, stands a better chance of success than do those nations that in order to preserve some fancied need of balance of power, sap the life-blood out of their people in military service which yields no return to the country other than the short physical and orderly training and the advantages that may be derived therefrom. While the immense armies of France, Germany and other countries are taking away from the producing power of each country, America is gaining many thousands of useful citizens by the addition of those who are willing and anxious to work and are forced to give up their own homes in order to avoid conscription.

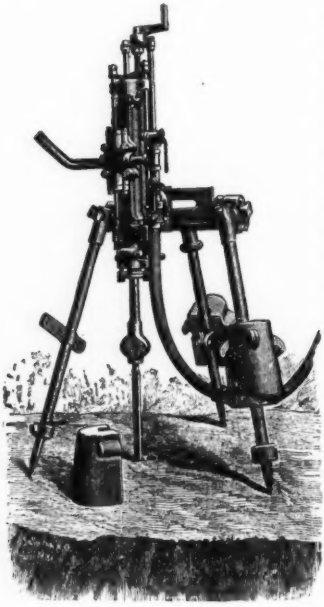
In studying the state of the art as to any particular instance of applied mechanics, the catalogues issued by manufacturers as presented to the American public amount often to scientific contributions giving valuable and reliable expression to the merit of the machinery manufactured. It is impossible in the treatment of this subject to go into all the examples of decided superiority but such typical examples must be selected as will prove the general claim.

We have shown the methods that obtain with machine-tool build-



SERGEANT DOUBLE-BEARING UNIVERSAL-JOINT QUARRY BAR.

ers, with locomotive-builders and similar manufacturing establishments, where the advance of the art is hastened by the earnest endeavor to produce superior machinery through years of careful observation and study as compared to building similar machines to the order and design of individual users. The acknowledged superiority of American mining machinery, the number of cases in which these machines are used in foreign countries, the necessity that there has been of starting branch houses in other countries, show that in mining machinery the same conditions obtain that apply especially to machine-tools, as in very many cases the manufacturers of mining machinery are the ones who have put it into use and watched its development.



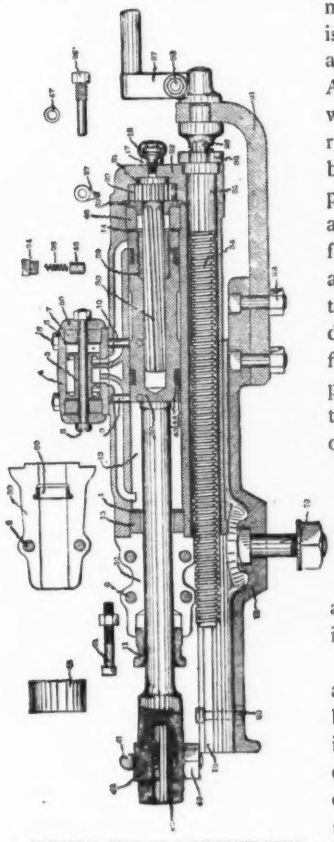
SERGEANT DRILL MOUNTED ON LEWIS HOLE TRIPOD.

With the exception possibly of agricultural machinery, which is so clearly and distinctly in advance in this country owing to the immense area of land to be cultivated and the nearness of the manufacturers to the agricultural area, mining machinery may be taken as an illustration of progress as the result of well-defined laws already alluded to, viz. : the scarcity and high price of labor ; that characteristic American temperament that prompts men to make haste in what they are doing and which is ever thirsting after improvements, and the fact that the perfection in every machine is a matter of development. American machines in this line are developed from already established

MORAN FLEXIBLE STEAM-JOINT.

foundations so that the structure gradually approaches perfection as results are noticed.

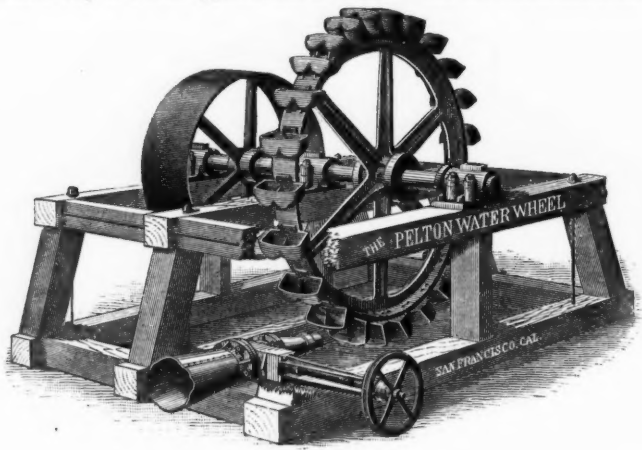
For instance, in the case of the rock-drill, there may not be many manufacturers of successful rock-drills in America compared to the number in England, and yet there is reason to believe that ten times as many such drills are used in America as in the rest of the world. This particular tool has reached its usefulness and value because it has been built up by the people who use it. If you take any example of a rock-drill, such for instance as the Ingersoll drill, a study of its record will show that seventy different styles of drills have been made by this one firm, each departure being an improvement that has been suggested by experience in some place or other, so that this large experience under varying conditions has brought out weak points, and manufacturers who are watching act to their own interests, take advantage of such experience and perfect their machines accordingly.



SECTIONAL VIEW OF A SERGEANT DRILL.

When rock drills are built just as some steam-engines are built, by people who are not particularly interested in the use of the machinery themselves, there will be observed a continuity of the same style showing, as years go by, little change, and these styles if compared with others, are identical with those that have been abandoned in America as not being perfect enough. So far as my own study goes in this branch of applied mechanics, it seems to me that the rock drills have in many cases abroad been designed for certain mines and tunnels, apparently by the dictation of the engi-

neer in charge of those tunnels, while in America the contractor who decides to equip with machinery looks at once to the manufacturers in that line, taking it for granted that their experience is better than his and that they can furnish better machinery than he can design and build. Those who work in the other direction may spend years in going over old ground which has been travelled long before by those who have made it their sole business to make machinery for any special purpose. This holds particularly in the case of machinery which has gradually developed to suit the best condition of the purpose to which it can be applied. Often foreign machinery bears the name of some particular place to which that machinery was first applied, and criticised from the American stand-

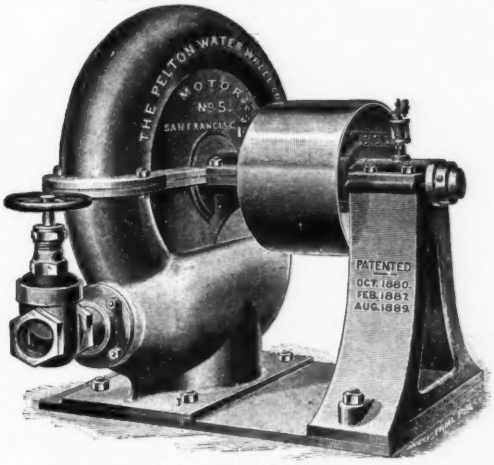



A MODERN WATER-WHEEL.

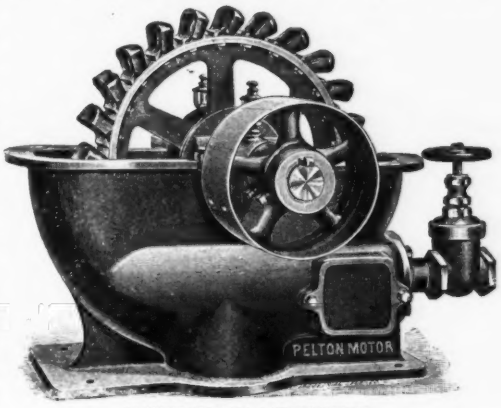
point they resemble their American prototypes of probably fifteen years before. The number of rock-drills alone that have gone from America to India and to the English companies in South Africa, and Wales and the Spanish-American countries and Australia, speaks volumes in favor of the progress that is made in applied mechanics as illustrated by this one example.

The mining interests of America are so varied in their conditions and requirements and there is such an immense field for original research as to methods that it is not surprising that the development of mining machinery should be more rapid where the needs are so great. California alone, or at least the western part of the

United States, including all the rich mining country near to the Rocky Mountains, has been developed by men who have had to exert themselves to their utmost to overcome difficulties incident to the varying conditions of the material operated on. The development of hydraulic mining in the development of the many machines required to work the metal-bearing rocks of the Pacific Coast has been effected by the men who are interested in the results to be produced. Often their methods may be criticised as unscientific, but seldom can they be considered as unpractical. One of the most noted instances of the practical solution of the mechanical problem is given in the development of the Pelton water wheel, a system worked out entirely by and through experimentation. Results have been achieved by these improvements on wheels that were among the earliest used, so that the history of the Pelton wheel is typically American and




A MODERN WATER-MOTOR.




ANOTHER VIEW OF A WATER-MOTOR.

stands as a monument of human ingenuity meeting the definition that has been given of mechanical engineering, "common sense applied to practice."

Having made the assertion that the advance in applied mechanics is due to what is in some degree under our control, and being strongly impressed with the advantages offered by our great national resources, our ability to make use of methods not permitted in other countries where legislation extends to the minutia of detail, often impeding progress from fear of intrenching on some vested rights where stringent trade laws for the assumed protection of persons and for sanitary purposes are often so binding as to retard improvement.

In the interest of the employés and the employers, it would be well if methods of manufacture are carried out that will increase the wages by increasing the product sufficiently to warrant the higher wages. This can be done most readily by those who are willing to deal fairly with the men with the intent to have their employés recognize and appreciate this justice that must work both ways. The employer who is benefitted by one workman operating two or more labor-saving machines should fully recognize the right for such men to earn high wages in a country where the skilled workmen are in demand, in fact where the supply of such skilled labor is always less than the demand. The workmen can then afford to take advantage of their increased wage-earning capacity by this increase of production.

Workmen and employers have the undeniable right to unite in their own interests with the intent to better themselves, but such union may be impolitic when by stringent laws they limit production and tend to reduce to a level of mediocrity either the wage-earning capacities of the employés or the producing power of the employers.

America has welcomed to her shores people from all lands. Mistakes have been made in admitting freely those who bring from their home the trade prejudices and customs that are not suited to our conditions. A self-governing nation must be made up of individuals who are each capable of self-control and who aim to do right, each capable of defending his rights, without doing others any wrong. Our ports have been opened too wide perhaps, and we may have to suffer for admitting too many who are incapable of appreciating the advantages offered by this country, but we must continue to welcome all who are ready to give up local prejudices

and accommodate their lives to the habits and methods of a land that may be the fatherland of their children.

The conveniences that are multiplying in American homes for home comforts, the methods of heating and ventilating, the improvements in sanitary plumbing, the universal adoption of the home bath-rooms in place of the public baths of Europe, or rather in addition to such baths, have all incited American ingenuity to a high pitch, making possible conditions of home life even among the laboring classes that are incomparably better than what one sees in the great cities of Europe. The tenement houses that are thronged in our great cities teem with life that is not native-born. In these great buildings crowd the people seeking our shores for remunerative work and who accept as natural to them a manner of living that is ill-adapted to the wants of the native American, who in his better furnished home rears families that may one day do honor to Fifth Avenue, Walnut Street, or any of our great cities.

What is making America foremost in applied mechanics is not what men do only but what women, too, are accomplishing. The makers of our men, the women who from education are capable of advancing as their husbands advance or even who can aid their husbands' mental growth, who can take part in the training of their sons and who from our system of co-education lose none of the charms of womanhood, give to their sons traits of character that are purely American and may some time come to be regarded as such when the typical American has been developed out of the gathering of many nations in this new land.

In selecting young men for trades in America it is not an uncommon thing to inquire more about the mother of the boy than about the father. The boy who has been brought up by a capable, industrious, painstaking, orderly mother is more apt to be industrious and able to make himself useful in a short time, than the son of an amiable but indolent and careless woman, no matter what may be the good qualities evident in the father.

Dr. Oliver Wendell Holmes in answer to a letter on the subject of the selection of apprentices and the desirability of information as to the mothers rather than the fathers, replied in his usual bright way that he was pleased to hear what was said on this subject as it greatly relieved his own mind, feeling sure that his wife's good qualities would amply compensate for all the disadvantages arising through his side of the house in relation to his own sons.

[*CONCLUDED.*]

# THE URANIA INSTITUTE OF BERLIN.

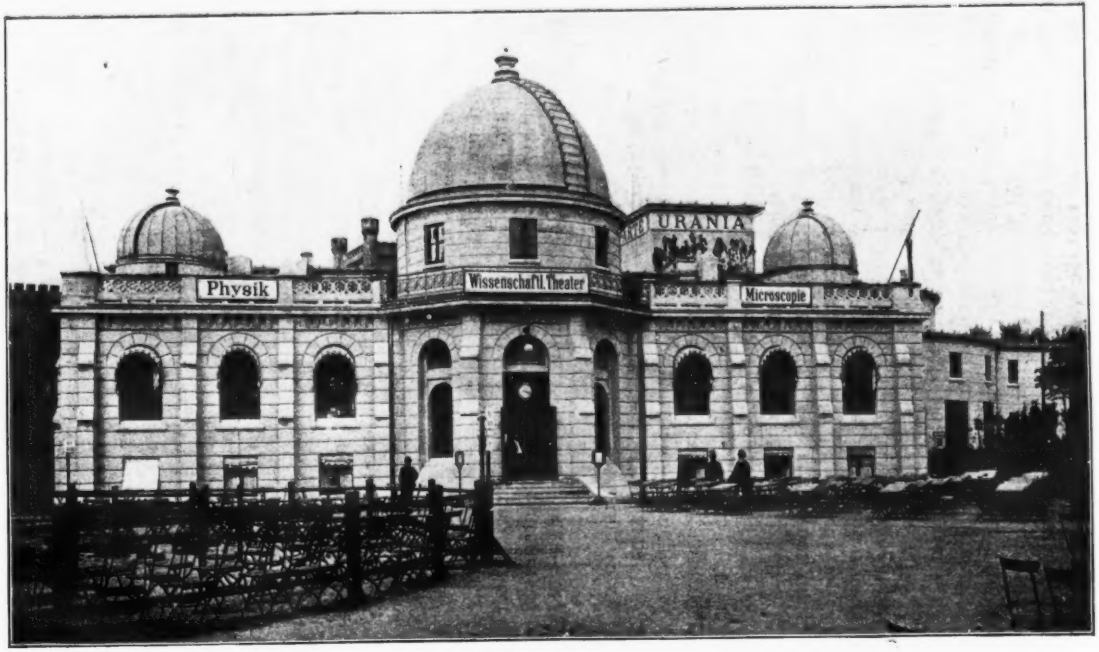
*By Edward S. Holden,*

*Director of the Lick Observatory.*

HAVING been asked to write for this magazine a short account of the Urania Institute of Berlin, I am very glad to do so, because I am in entire sympathy with the plans of the establishment, and especially because it is now proposed to constitute such popular observatories in various American cities if sufficient interest is shown by those most concerned—namely, the intelligent citizens of New York, Chicago and other leading cities. It seems to me that this interest will not be lacking when the plans and scope of such institutions are understood.

The working observatories of the world are none too well endowed and they require the whole effort of their staff of astronomers to promote science, and can spare no time nor energy for the diffusion of the knowledge thus gained. Advanced students are admitted as pupils, and on special occasions other visitors have access to the observatory and instruments for a single evening. No regular provision can be made for the wants of that very large and intelligent section of the public which is intensely interested in the results of astronomical observation and even in the larger outlines of scientific methods, but which does not care at all for the small details which the special student must attend to. Professor Foersher, the Director of the Royal Observatory of Berlin, had long felt the want of a popular astronomical institute which should provide for such needs, and which might serve to relieve the pressure upon the Royal Observatory itself, whose energies were all used in strictly professional work. In 1887 this idea took shape through the interest of Dr. M. W. Meyer (formerly one of the astronomers of the Observatory of Geneva), and by Dr. Meyer's advice the scope of the proposed establishment was materially extended, so as to include microscopy, physics, etc., as well as astronomy.

The project was carried out early in 1888 in a very business-like way. One hundred and twenty-two gentlemen who were interested met in March of that year and formed a stock company—the Urania Gesellschaft—with a capital of $100,000, distributed in shares of about $125. Dividends *not to exceed* 5 per cent. may be



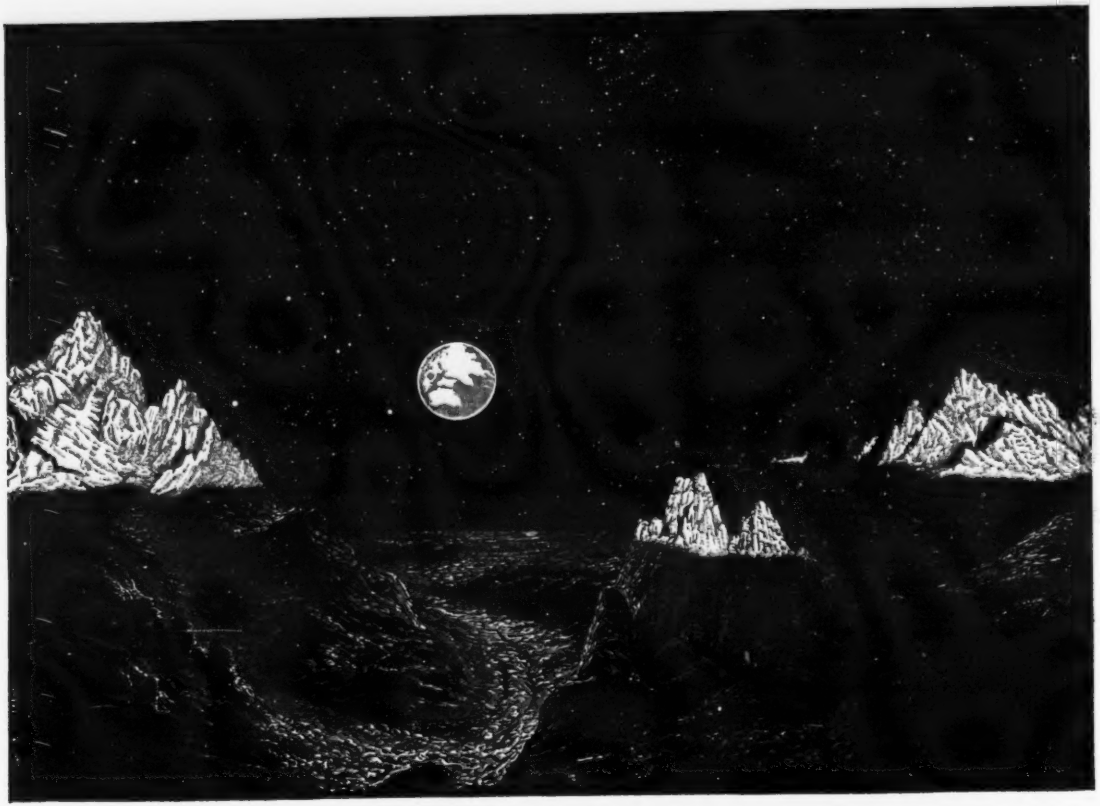

THE URANIA INSTITUTE, BERLIN.

paid, and each member has rights of admission and also receives a copy of the Journal of the Institution. There are now some 400 or 500 regular members, I believe.

The work of the institution is divided into five principal departments—astronomical, physical, mechanical, microscopical, and the department of public instruction by lectures and otherwise. Each of these departments is under the direction of a special official, usually one of the professors of a university. Dr. Meyer is the superintendent of the whole institute and the chief editor of their monthly journal, *Himmel und Erde*. There are also some thirty to forty minor officials, exclusive of the editorial staff. Some of the cuts which illustrate the present article are reproduced from *Himmel und Erde*, by permission. The astronomical department is amply provided with telescopes, ranging from a powerful 12-inch telescope down to smaller portable instruments suitable for viewing the moon, etc. These are under the charge of competent observers who make it their business to give full explanations of what is seen. Usually the visitors are asked to go into the lecture hall, after looking through the instruments, and there a short address is made by one of the astronomers, illustrative of the special planets or stars which have just been viewed. The electric-lantern is usually employed at these lectures to exhibit photographic slides, of which the Institute has a fine collection.

The physical department is especially interesting to visitors, and this is largely due to the arrangement of the apparatus. In the other departments the apparatus must not be handled. In this, each piece is so arranged that the visitor can set it in motion by touching an electric button near it, and after reading a printed explanation of the phenomenon he is going to see. For instance, the first push-button sends a powerful current through a coil of platinum-wire which is heated to redness. The next sends the same current through coils of different metals and their behavior can be compared. Another case illustrates the decomposition of water by electricity, and so on. It is plain that much may be taught by such apparatus, devised and arranged, as it is, under the direction of highly-trained scientific specialists. Mr. Edison was greatly pleased by his visit to Urania, and with his accustomed liberality he has made them valuable presents of electrical machines and apparatus.

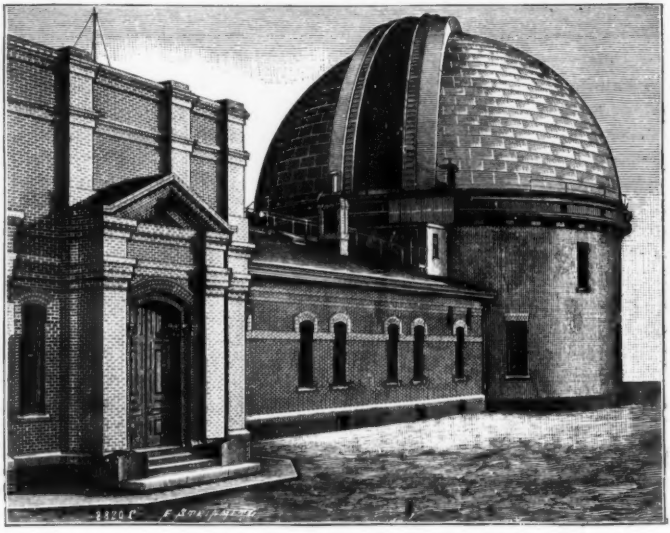
The microscopical department is arranged on the same principles. A great number of compound and simple microscopes are conveniently arranged, so that the visitor may readily examine a great



ONE OF THE LECTURE SCENES OF "URANIA."

variety of objects, as crystals, diatoms, low forms of animal life, parts of insects, etc. Among the interesting features of this department is an apparatus which renders visible the development of the chick, the egg being warmed by electricity.

The other departments are all arranged on the same general principles, with variations. It remains to speak of the department of public lectures. These are delivered in a suitable theater by a professional lecturer. One of the actors of the Royal Theater of Berlin is the present lecturer, I believe. The lectures themselves are, however, carefully written out by competent specialists; those on astronomy, for example, have been written by Dr. Meyer. The lantern is used constantly to exhibit photographic slides, of course, but the chief features are realistic spectacular effects, whenever these can be introduced appropriately. For instance, a lunar or a solar eclipse can be imitated very closely. In the "History of the Primeval World" the spectators see the gradual evolution of the earth from the chaos of the original nebula; they see the lightning and the eruptions and hear the thunder of the tremendous struggle between fire and water as the



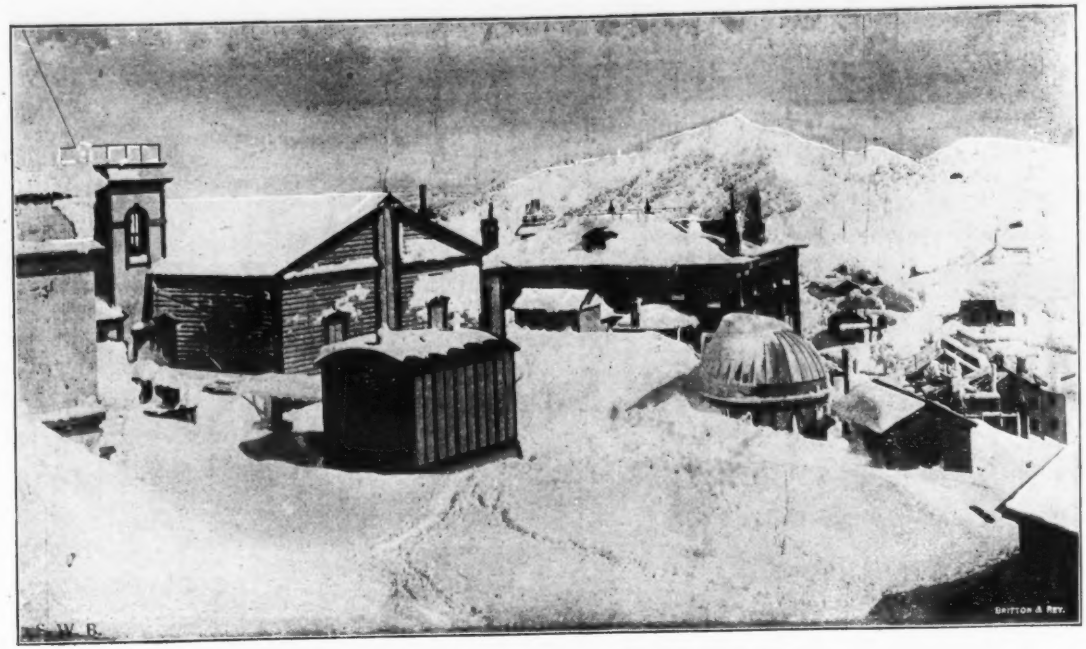
SOUTH HALF OF LICK OBSERVATORY.

LICK OBSERVATORY IN WINTER.
[By the courtesy of "Himmel und Erde."]

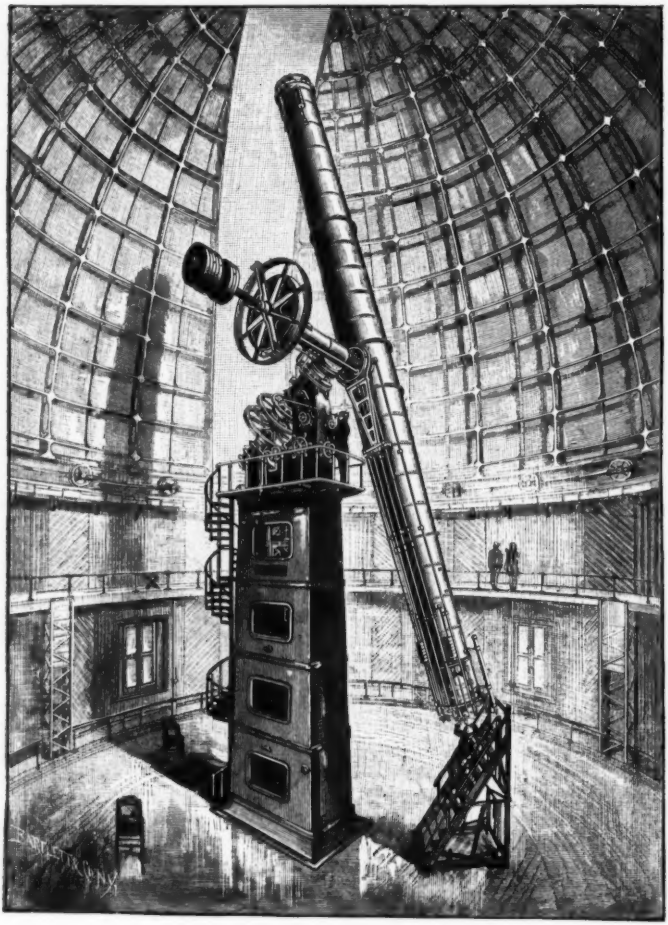
earth gradually cools, and trace in the shifting scenery the changes which led up to its present peaceful condition.

I have, no doubt, said enough to give a fair idea of the objects of the Institute and of its general plan. It remains to present a few statistics; and here I am obliged to speak only of the first year of the existence of Urania, as the later reports are not now accessible to me. In the first year, then, the Institute was open on 268 days; it was visited by more than 95,000 persons; of these 11,000 were school children, 6000 were members of workingmen's societies, 8000 were members of other societies; 313 lectures of ninety minutes long were given, and no less than 582 lectures of thirty minutes; finally, the institution paid expenses and something over, although the entrance fee is, I believe, never more than twenty-five cents, and for workmen and school-children only five cents. The average receipts were $98 per day, the greatest receipts for a single day being $221. I believe that these figures have been very much exceeded since the first year. The foregoing statistics speak eloquently of the immense usefulness of this popular scientific institute in its very varied relations, and the splendid success of its first year's work is a promise of continued prosperity. The benefits which it confers are wide reaching, extending as they do from instruction of thousands of school-children up to opportunities of research afforded to trained scientists.

Mr. Andrew Carnegie has made arrangements for producing a few of these lectures, under the personal supervision of Dr. Meyer, at the New York Music Hall, and has spared no expense in importing all the necessary theatric "properties" so that everything may be produced in the most realistic and in the best manner. New York audiences will soon have an opportunity of judging for themselves. I think that these lectures cannot fail to be successful in every way. They are university-extension in a very practical form, and as they are planned and directed by men of real scientific attainments there is no danger that they will degenerate into mere sensational "shows." I understand that Mr. Carnegie's idea is to discover whether there is a real demand for such institutes in America, and to assist in founding them, if there is. My own experience at the Lick Observatory leads me to believe that large cities, like New York or Chicago, will gladly support such establishments, particularly if they receive the hearty support of neighboring astronomical observatories, as no doubt they will. At the Lick Obser-




GENERAL VIEW OF THE SUMMIT OF MOUNT HAMILTON, FEBRUARY 20, 1890.



THIRTY-SIX INCH TELESCOPE, LICK OBSERVATORY.
[By courtesy of Warner & Swasey.]

vatory, which has been open a little over three years, our visitors' books show more than 16,000 visitors, and with us a visit means a stage ride of fifty miles, an expense of two days in time and of $10 in money at the least. Moreover, the Lick Observatory is open to

the public on Saturday nights only. We have formed, also, an Astronomical Society of the Pacific which includes more than 400 members, many of them ladies, and which regularly publishes brief and popular illustrated accounts of the work which the Observatory is doing. In this way we are able to reach the very many intelligent persons who are intensely interested in results and who wish to understand, in a general way, how they are reached, without making special astronomical studies. I hope and believe that our society will accomplish its object and I look to see its membership largely increased. The fees are small, only $5 per year, and the journal contains several hundred pages annually.

The views of the Lick Observatory given here are copied from the publications of our Astronomical Society and serve to give a general idea of the institution. It will be plain, although our first object is the advancement of science, that we do not neglect the diffusion of knowledge, and that we constitute an important part of the educational machinery of the community. Our experience here has demonstrated to me the wide and intelligent interest which is felt in science by Americans in general and has given me a lively sympathy with such undertakings as Urania in Berlin and its proposed counterpart in New York. I am sorry that it has been necessary for Americans to go abroad for the idea, but I hope that it will be quickly adopted and liberally supported. I know of no way in which sound and solid ideas regarding science may be made to take the place of loose and silly ones, which is at once so effective and so simple as the plan of Urania, and I feel sure that it will command the success that it deserves.

# DANGERS FROM TALL OFFICE BUILDINGS.

*By Henry A. Goetz.*

THE modern tall office building has its advantages in the economy of ground space and in the increased amount of light and better ventilation which may be enjoyed so long as each tall building stands apart from other structures of the same class. There are some very serious faults in some of these buildings, however, which are developed only during a conflagration, which makes it proper that the methods of construction should be considered from the standpoint of the fireman ; and this will be attempted on a brief scale in the present paper.

The extensive use of iron as a material for the construction of buildings, which has grown up within the past fifty years, had its first great impetus in the popular belief that anything built of iron was necessarily fire-proof. The fallacy of this belief has been amply shown in the experience of recent years. The great fires in Chicago, Boston and St. Louis demonstrated thoroughly that iron was a most treacherous building material. Within the past fifteen years, however, great advancement has been made in fire-proof construction, especially in the arrangement of material. The old brick arch has passed out of existence, giving place to the hollow arch of terra-cotta ; the once exposed iron beam is now covered with non-combustible material, while iron columns are encased and ornamented until it would seem impossible ever to make the columns hot enough to cause a collapse.

The apparent protection which this new method affords against fire is the primary cause for the very tall office buildings going up in all our great cities, every syndicate or owner trying to overtop the buildings of all predecessors. There is the *World* building in New York, eighteen stories high, to be outdone by the Oddfellows in Chicago, with twenty-two stories, and perhaps later by the *Sun* in New York, with thirty-two. Rivalry is a good thing, but in this case it is possible that it may be overdone, ending in some great calamity which will lead the legislatures to pass all sorts of laws that will make the owners of tall buildings wish that they did not have any. The Auditorium in Chicago is a good illustration of the best type of fire-proof building. The walls and the steel

framework in the structure could be separated and either would stand alone.

An entirely new system of construction now coming in vogue is in danger of bringing the whole business of fire-proof construction into discredit through some awful disaster. This method is that in which the iron or steel frame is erected first, and made to support the outside wall for each story. This method will, of course, find great favor with the economical owner ; he can skin down the cost until the structure is built just within the limits of safety otherwise, but overlooking entirely the danger of loss from fire. In speaking of fire it is admitted that there may not be enough of a combustible nature in the building to do any damage ; and that a fire in any room would simply burn itself out without serious damage ; and that no fire started in the interior could do any damage. Where, then, is the danger ? *The danger to all fire-proof structures is from the outside.* It is from exposure to fire from other buildings.

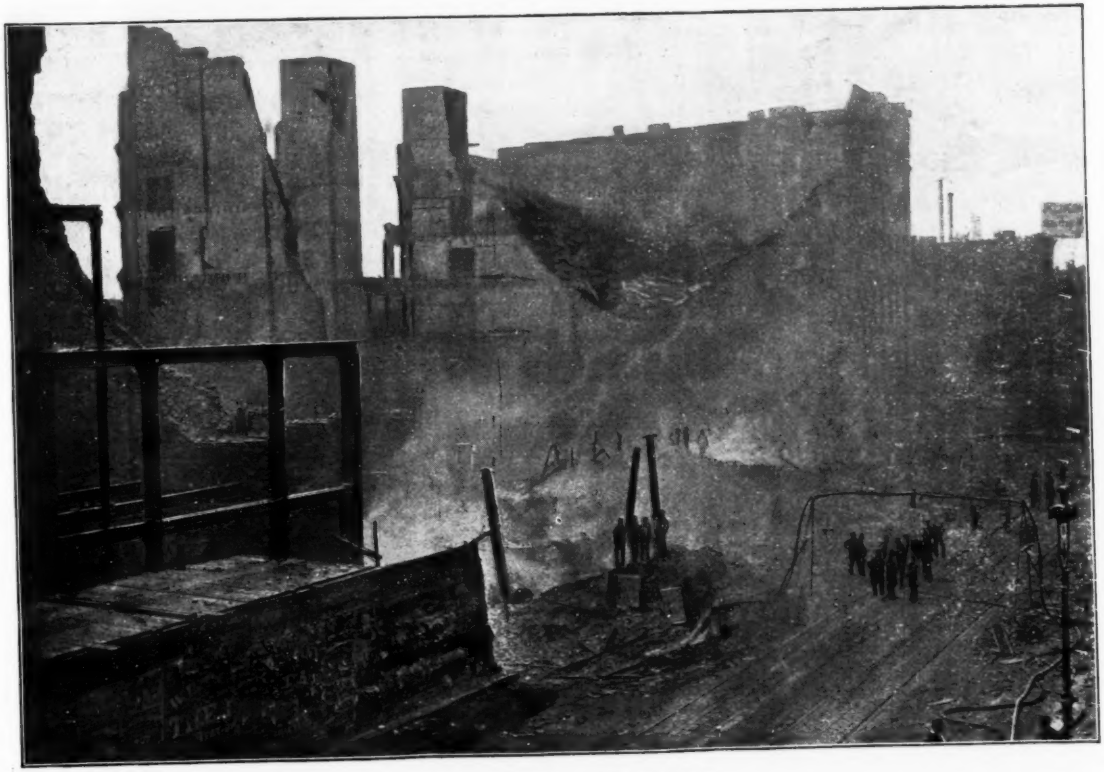
At the Thanksgiving fire in Boston, in 1889, Fire Marshal Whitcomb reported that about forty minutes after the alarm was sounded the Brown-Durrell building collapsed, the walls falling out while the floors tumbled in. The air pressure thus created was sufficient to blow in bodily the large lights in the front of the Ames building before they were all cracked by the heat. This left an

THE AUDITORIUM, CHICAGO.

PORTION OF RUINS OF THE BROWN-DURRELL BUILDING, BOSTON.

unobstructed passage for the flames into the Ames building. It appears in evidence that just previous to this the iron roof, becoming expanded by the heat of the flames which were rushing over it from the Brown-Durrell building, gradually spread the walls and fell in. The Ames building was built on the slow-burning principle except the two upper floors, these being built of iron **I** beams filled in with concrete on corrugated-iron arches, the roof being entirely of iron and covered with heavy fire-clay tiling. This building is given as an instance of what would have happened to it even if it had been a modern fire-proof building, for in this case the roof expanded and caused the collapse. It is important, therefore, in making designs, to consider the possibility of sudden collapse by the great heat from adjoining structures. In the Ames building the fire came from the front.

We may now call attention to the danger from adjacent or next-door buildings. Many tall fire-proof buildings are now being built in which the steel columns that support the structure are encased in the brick walls with but four inches of brickwork protecting the iron work, upon the *exterior* side of the wall. In case of a severe fire among the buildings adjoining, the exterior four inches of brick *would be no protection whatever*. The bricks would become hot and these in turn would cause the column to expand enough to displace some of the tile arches and these in falling would cause others to fall until finally the building would be a total wreck. In the new addition to the Western Union Building, on Dey Street, New York, the steel frame is placed directly against the wall of the smaller building; in case of a conflagration the small building would pull down its own wall and expose the steel frame of the Western Union, so that it can easily be seen that the result would be disastrous. The great Madison-Street fire in Chicago illustrated this. The fire-proof building was under way, six stories being up, the iron work being placed directly against the party wall. A fire in the adjoining building of the Smyth Furniture Company forced the wall to fall, exposing all the iron work of the partly-finished building, causing a general ruin, for the whole thing, while it did not burn up, was twisted so badly as to be useless. In this case the wooden joists of the Smyth Building were fastened to the party wall with the old style strap anchor, and when the joists fell the wall had to go. No tall building should be erected that does not make use of its own individual side walls, these walls being so constructed and tied to the beams that no falling beam can



THE GREAT MADISON-STREET FIRE IN CHICAGO.

break them or cause them to fall. These dividing walls should be an absolute barrier against fire and should not be made thin and weak. Architects should remember that this class of buildings is only assailed by a conflagration and nothing can withstand a conflagration so well as a standing brick wall. Many architects do not think it necessary to tie the beams to the wall, believing that the weight and friction are enough to hold the walls. This may be all right in ordinary cases, but in extraordinary cases, such as the occurrence of fire, the walls should be held in position as long as possible.

The beams in the Ames Building were not anchored, which probably accounts for its quick collapse. The beams in the Madison-Street building were not anchored, which accounts for that. Architects as a general thing do not pay enough attention to the method of anchorage. In many specifications nothing whatever is said on the subject, leaving the builder free to select anything that suits his economical notions. It is important that all beams whether of iron or wood be anchored to the wall so as to be a good tie, and at the same time a falling beam should be able to free itself from its anchorage.

Within the last few years some of the fronts are being built of steel and iron, the whole being encased in a thin terra-cotta shell. This will certainly not stand fire so well as a brick front, for should any one section of this thin shell be broken during a fire it will expose the iron and thereby cause a collapse. No such fronts, therefore, should be built where there is any liability to the exposure hazard. Insurance companies are awakening to the fact that the exposure hazard, that is where fire is communicated by the adjoining premises, has been neglected and overlooked in their estimate on insurance rates. From careful statistics they discover that 40 per cent. of the total loss from fire is caused by exposures. The past year was a very disastrous one for the underwriters and the proportion of 40 per cent. was doubtless increased.

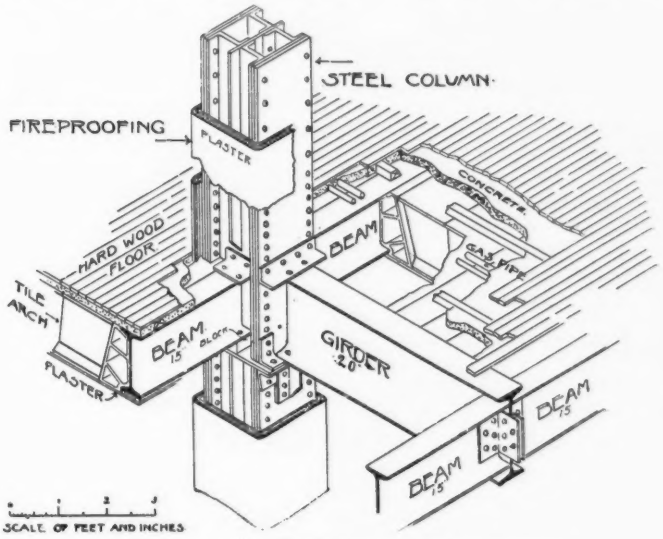
A certain Fire-Chief when asked if he considered a certain building fire-proof said that its fire-proof quality depended not so much upon the building as upon its contents. He said that he had seen fire-proof structures succumb quickly, and that he felt his life much safer fighting fire in a structure with timber floors than in a fire-proof structure. Architects often overestimate the ability of their building to withstand fire and add wood and ornamentation until they have neutralized its fire-resisting qualities. The

WESTERN UNION TELEGRAPH BUILDING, NEW YORK.

[Showing addition on the left, in a different style of architecture, adjoining smaller building.]

Western Union Building clearly illustrated this, it being filled with openings from floor to floor through which the telegraph wires were passed, the whole being covered with wood. A crossed wire started a fire that could not be controlled until all the upper floors were completely destroyed. One of the views accompanying this paper represents the new addition (the destroyed part being rebuilt) showing a strong and ugly contrast to the old part.

When we consider the difficulties firemen labor under in being compelled to carry hose up say ten to twelve flights of stairs—elevators not being on duty during fires—is it any wonder that they object to tall buildings? One Chief said at a recent fire that his

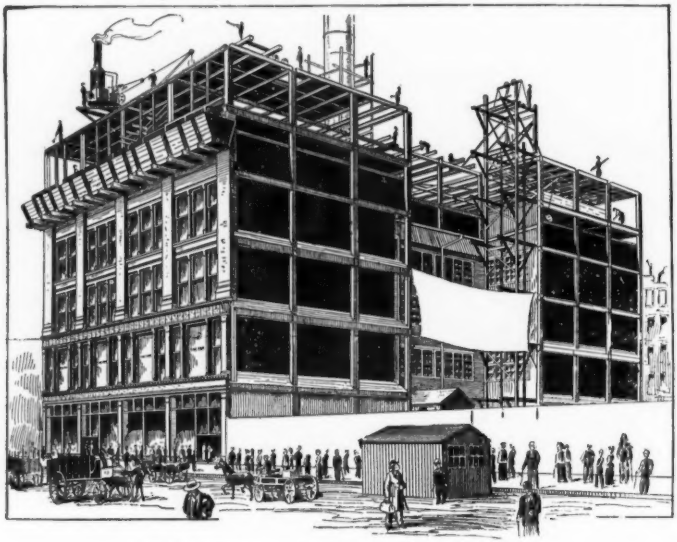



ISOMETRIC VIEW OF AN INTERIOR COLUMN—"THE FAIR," CHICAGO.
[From "The Inland Architect."]

men were so much exhausted in climbing up the stairs that when they arrived at the top they could do nothing. He himself was so exasperated about the height he had to climb that he told his men to sit down and rest and "let the damned thing burn down," forgetting that he and his men would likely burn with it.

Another fatal error often made is with the *shaft* that contains water and gas-pipes and wires. The Stillman Hotel, at Cleveland, Ohio, a modern fire-proof building, had a fire in its upper floor

which destroyed the roof. While Chief Dickenson and his men were fighting the fire on the eighth floor, he discovered another fire three floors below him, which threatened to cut off his retreat to the street. The beams began to expand, thereby causing parts of the tile floor to drop out, and some of the men narrowly escaping death, but the fire was finally put out. An investigation by the Chief revealed that the carpenter had permitted the wooden floor to project into the shaft. The fire from the eighth floor dropped down the shaft and lodged upon the wood projection of the fifth floor, quickly burning the wood casing, this in turn igniting a wardrobe and the wood-work. Architects should therefore pay more attention to the shafts and see that they are not made fire-traps or conductors of fire. A fire-stop should be made at each floor in all cases, so as to prevent fire passing from one floor to another.



VIEW OF CONSTRUCTION OF "THE FAIR" BUILDING, CHICAGO.
[From "The Inland Architect."]

It is by no means a settled question that the modern steel structure will endure the ravages of time. It is well known that steel is liable to rust; it is also well known that dampness will pass through any brick wall. The conclusion therefore must naturally

be that four inches of brick or two inches of terra-cotta will not protect the steel frame from moisture.

It will be a difficult problem to replace any column that should become weak through rust, and the danger of sudden collapse from this cause cannot be guarded against, because periodical inspection is impossible. Iron and steel bridges are usually kept well painted to prevent rust, but notwithstanding this great care many parts must be renewed after eighteen to twenty-five years. I have serious misgivings that some of our modern steel frame structures will not arrive at the age of two-score-and-ten.

Chicago Underwriters have probably had the largest experience with the fire-proof building, and while they do not make any special objection to the tall *office* building, they have taken a decided stand against such a building if it is to be used for mercantile purposes. The rate of insurance on the building and stock of such tall mercantile buildings is $3\frac{1}{2}$ per cent. This rate will practically prohibit the erection of such buildings, and will cause the owners of those already erected to look about for non-hazardous tenants. It may be mentioned that the Chicago Fire Underwriters' Association has adopted a resolution that all office buildings of non-combustible construction hereafter erected in that city shall be limited in height to not more than one and a half times the width of the street, and on streets of more than sixty feet in width the height of such non-combustible buildings shall be limited to 120 feet; also that the height of buildings of other than fire-proof construction shall be limited to eighty-five feet, and that no building except office buildings, whether fire-proof or otherwise, shall exceed eighty-five feet in height from the street level to the highest point of the roof.

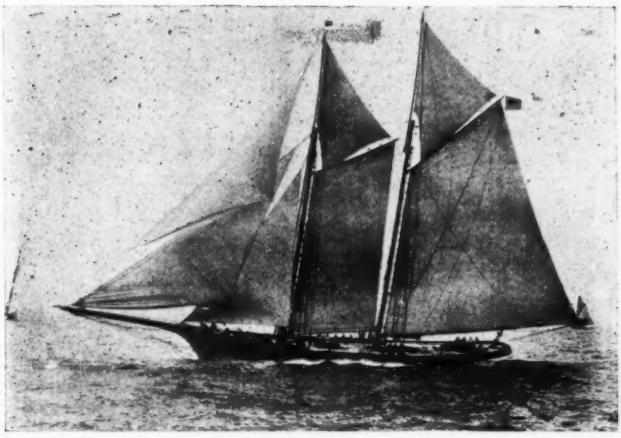
# YACHTS OF NEW YORK HARBOR.

*By W. J. Henderson, A. M.*

THE history of yachting in America begins with the organization of the New York Yacht Club, July 30, 1844. Previous to that time yachting had led a precarious and sporadic existence, but the first regatta of the young club, on July 16, 1845, established the sport on a firm basis. The vessels which started in that race were the following schooners: W. Edgar's *Cygnet*, C. B. Miller's *Sybil*, H. Wilkes's *Spray*, John C. Jay's *La Coquille*, J. Waterbury's *Minna*, and J. C. Stevens's *Gimcrack*; and the following sloops: H. Robinson's *Newburgh*, J. Rogers's *Ada* and G. B. Rollins's *Lancet*. The *Cygnet* was the winner. The schooner was the favorite craft in those days. All the schooner yachts were built wide, with perpendicular or slightly convex stems, square sterns, short standing bowsprits and no foretopmasts. Balloon canvas of all sorts was unknown, and no one ever had to lay out to muzzle the jib topsail, because there was not any.

THE "AMERICA'S CUP."

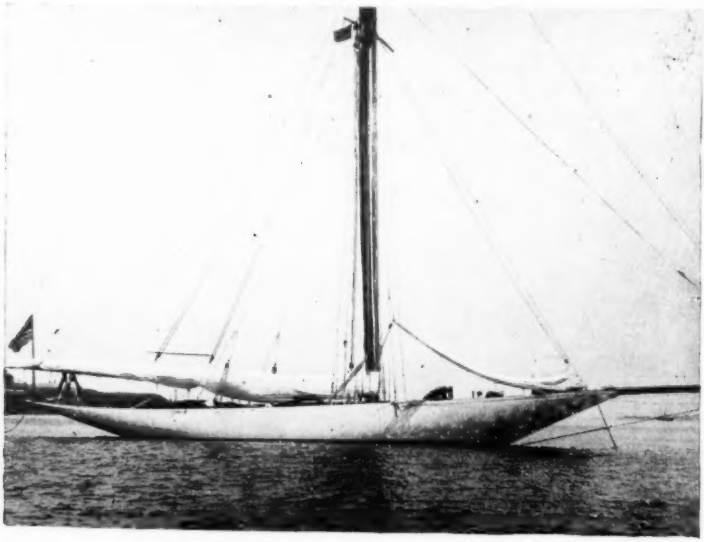
The club built itself a house at Hoboken the next season and started and finished its races off that place for more than twenty years. On October 10, 1846, two of the club's yachts, the sloop *Maria* (154 tons!) and the schooner



THE SCHOONER AMERICA.

*Coquette*, sailed the first ocean race, twenty-five miles to windward and return from the Gedney's Channel entrance buoy. The schooner won by 26 min. 30 sec., in 6 h. 35 m. 30 sec. The *Maria* was one of the productions of the noted builder Steers. She had great beam and great sail spread, but had to be altered to a schooner on account of the size of her spars. The famous sloop *Una*, more like a craft of 1885 style than any of those early sea-birds, made her début as a winner in 1847. The club continued its lively races year after year, sometimes giving Corinthian regattas, till 1851, which is the most memorable of those early years, because then the schooner *America* made her appearance, crossed the ocean and won the famous "America's Cup" in a race around the Isle of Wight. As I am not giving a complete history of New York yachting, let us pass on to 1854. In that year balloon canvas (club topsails, etc.,) was admitted and the New York Yacht Club's first race at Newport was sailed, the *Maria* being the winner. This race established the custom of making annual cruises to the eastward. The following year the club had a regatta off Glen Cove, the first race in Long Island Sound.

In 1855 the long series of troubles about time allowance began. The men whose old-fashioned yachts carried no balloon canvas put through a time-allowance rule taxing sail area, a rule which some yachtsmen wish to see revived. In 1858 took place the first race around Long Island, starting at the Narrows and finishing at Fort

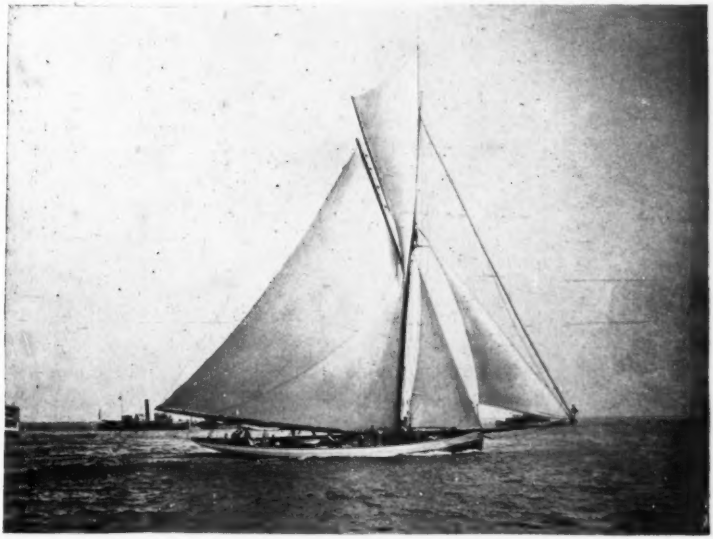


GLORIANA, E. D MORGAN OWNER.

Schuyler. Match races were numerous in those days and in 1860 the first race of twenty miles to windward and return from Sandy Hook was sailed by the *Julia* and *Rebecca* for $250 a side. The *Julia* won by 13 minutes. On October 9, 1866, the famous schooners *Henrietta* (James Gordon Bennett) and *Vesta* (Pierre Lorillard) sailed a rattling match in an easterly gale from Sandy Hook to Cape May lightship and return. The *Henrietta* covered the course in 30 h. 6 m., but the *Vesta* beat her 56 minutes. This led to the making of a match between the *Vesta* and George A. Osgood's *Fleetwing* for $30,000 a side to sail from Sandy Hook to the Needles, England. Mr. Bennett afterwards entered the *Henrietta*. The race began at 1 P. M. on December 11. The *Henrietta* sailed 3106 miles in 13 d., 21 h., 55 min., winning handily, with the *Fleetwing* second. The best day's run was 280 miles made by the *Henrietta*, in the twenty-four hours ending at noon December 17. I may as well add here that the largest day's run ever made by a yacht was made by the schooner *Dauntless* in her ocean race with the *Coronet* in 1887, when in the 24 hours ending at noon, March 25, she reeled off 328 miles. The next best run, 319 miles, was made by the schooner

*Republic*, owned by Mr. Hall, between the Bermudas and St. Thomas. In 1870 began the series of English attempts to recover the America's Cup which made that trophy the emblem of the world's yachting championship and did more to develop yachting in this country than all other factors combined. In that year the *Magic* defeated the *Cambria*; in 1871 the *Livonia* lost to the *Columbia* and *Sappho*. In 1876 the Canadian schooner *Countess of Dufferin* was beaten by the *Madeleine*. In 1881 the races passed over to single-stickers and the *Mischief* beat the Canadian *Atalanta*. There were no more attempts until 1885, when Sir Richard Sutton brought the cutter *Genesta* over and was beaten by the *Puritan*. The ensuing races between the *Mayflower* and *Galatea*, *Volunteer* and *Thistle* are still fresh in the public mind.

In 1881 the Scotch cutter *Madge* came to this country and beat our cracks in her class so persistently that yachtsmen opened their eyes and wondered what was wrong with our boats. The lessons taught by the *Madge* were applied by the famous designer Edward Burgess in his productions, and his work led to a line of development which totally changed the character of American yachts.

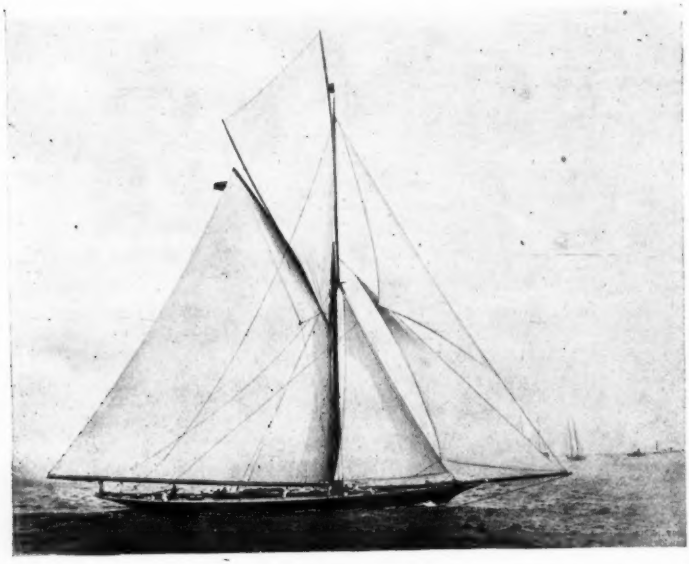


MAYFLOWER.

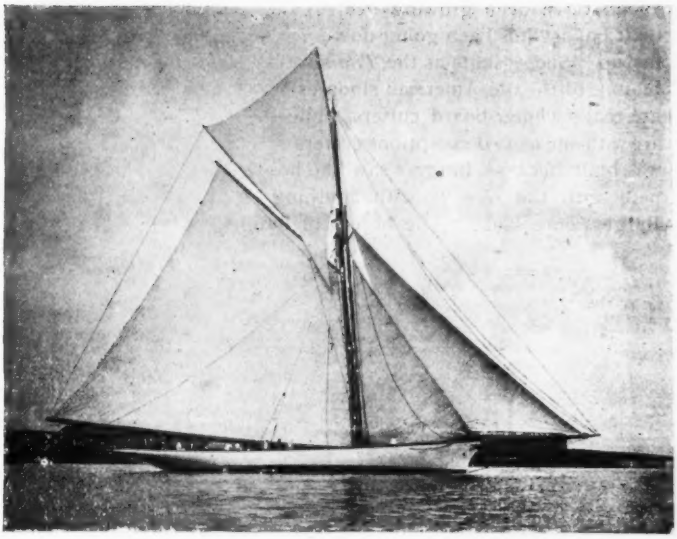
Previous to the appearance of the *Madge* there had been little or no progress in the designing of American pleasure craft. Let us look, for instruction, at the dimensions of the competitors for the America's cup, the lengths given being the water-line:

| NAME. | LENGTH. | BEAM. | DRAUGHT. |
|---|---|---|---|
| Magic | 78.11 ft. | 20.9 ft. | 6.7 ft. |
| Cambria | 100. ft. | 20.5 ft. | 12.4 ft. |
| Sappho | 119.4 ft. | 27.4 ft. | 12.8 ft. |
| Columbia | 96. ft. | 25.1 ft. | 6. ft. |
| Livonia | 107.5 ft. | 23.3 ft. | 12.8 ft. |
| Madeleine | 95.2 ft. | 24. ft. | 7.4 ft. |
| Countess of Dufferin | 107. ft.* | 24. ft. | 6.5 ft. |
| Mischief | 61. ft. | 19.10 ft. | 5.4 ft. |
| Atalanta | 64. ft. | 19. ft. | 5.5 ft. |
| Genesta | 81. ft. | 15. ft. | 13. ft. |
| Puritan | 81.12 ft. | 22.58 ft. | 8.66 ft. |
| Galatea | 87. ft. | 15. ft. | 13.03 ft. |
| Mayflower | 85.58 ft. | 23.5 ft. | 9.75 ft. |
| Thistle | 86.46 ft. | 20.03 ft. | 13.8 ft. |
| Volunteer | 85.88 ft. | 23.02 ft. | 10. ft. |

* Length over all.



THISTLE, W. P. BENNETT OWNER.

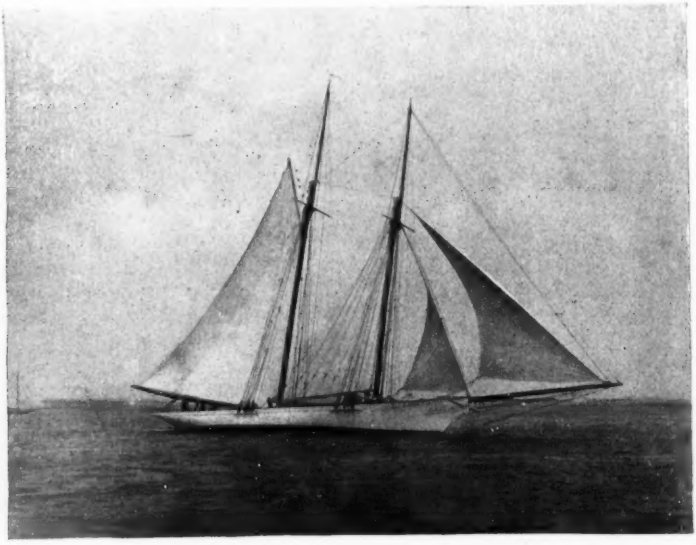


VOLUNTEER.

I will add to these the dimensions of two typical forty-six footers of the last season: *Barbara* (British) length over all, 63 ft., water-line, 45 ft. 9 in., beam, 13 ft., draught, 11 ft. 8 in. *Gloriana* (American) length over all, 70 ft., water-line, 45 ft. 3 in., beam, 13 ft., draught, 10 ft. 2 in. To these let me also add the dimensions of the *Fanny*, a typical racing craft of the years between 1875 and 1880: length (water-line) 65 ft., $8\frac{3}{4}$ in., beam, 23 ft. $3\frac{1}{4}$ in., draught, 5 ft. 3 in. She carried from 6 to 8 tons inside ballast in her palmy days. The *Volunteer* carried 55 tons, largely outside.

Now what do these figures show? Simply that the swift little *Madge* taught our yachtsmen that beam and initial stability were very pretty things in their way, but that the vessel with staying power in all kinds of weather was the one with less beam, less initial stability, and more ultimate stability. The *Fanny* with a beam of over 23 feet on a water line of less than 66, and a draught of 5 ft. 3 in., is a very different type of craft from the *Volunteer* (sloop) with a beam of 23 and a draught of 10 on a water line of 86. Ever since the advent of the *Madge*, when Mr. Burgess and others saw that our skimming-dish type was radically wrong for sea work, our

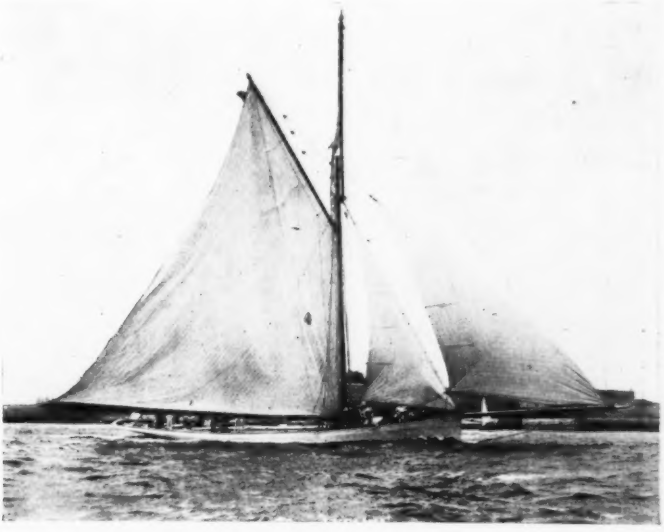
yachts have been growing deeper and becoming narrower; and their ballast has been going down as their topmasts have been going up. Such yachts as the *Titania* and *Volunteer* have not a single feature of the old American sloop except the center-board. They are really center-board cutters, while the *Gloriana* and her mates are with one or two exceptions cutters even to the keel. The *Puritan* was built because Burgess saw the hopelessness of trying to compete with the *Genesta* with anything we had at that time. Mr. Burgess once said: "The object in building the *Puritan* was not



CONSTELLATION. E. D. MORGAN OWNER.

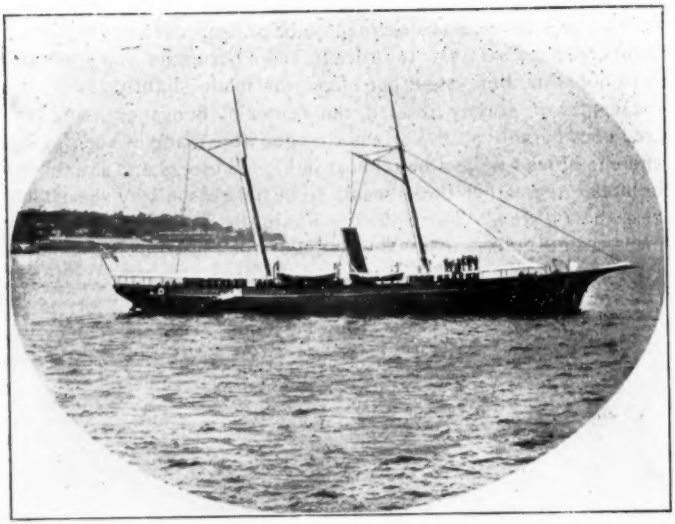
so much to get a vessel that would be particularly fast in light weather as to produce a good all-around yacht, and especially one that would give a good account of herself in a breeze of wind—at any rate a boat that would not disgrace herself in heavy weather." The performance of the *Puritan* in her second race with the *Genesta*, twenty miles to leeward and return, on September 16, 1885, in a housing-topmast breeze of from twenty-five to thirty-seven miles an hour, showed that she was certainly able to "give a good account of herself in a breeze of wind."

The *Mayflower* was designed to be an improvement in certain points on the *Puritan.* "In order to make her easier in a sea-way" —I quote Mr. Burgess—"her bilge was made slightly easier, and the center of gravity lowered, the center of buoyancy being lowered considerably also. Various changes were made in her rigging, and she proved to be a better boat in a good breeze and sea, though in moderate weather there seems to be no reason why she should beat the *Puritan.*" The *Volunteer* was in the direct line of development, a line indicated by Mr. Burgess when he said: "While the

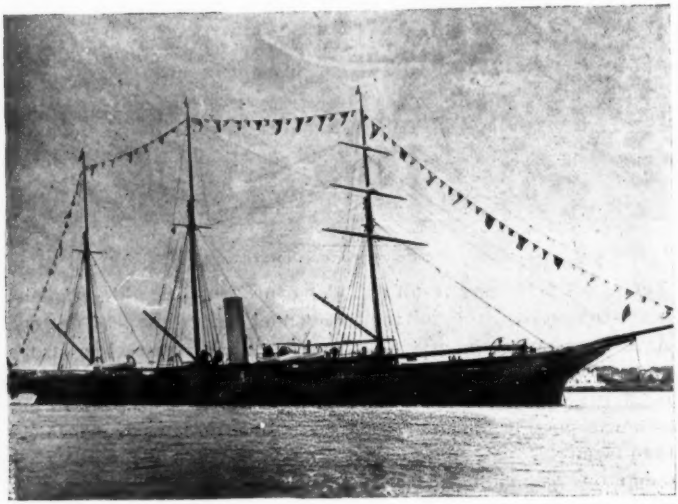


TITANIA, F. C. CRANE OWNER.

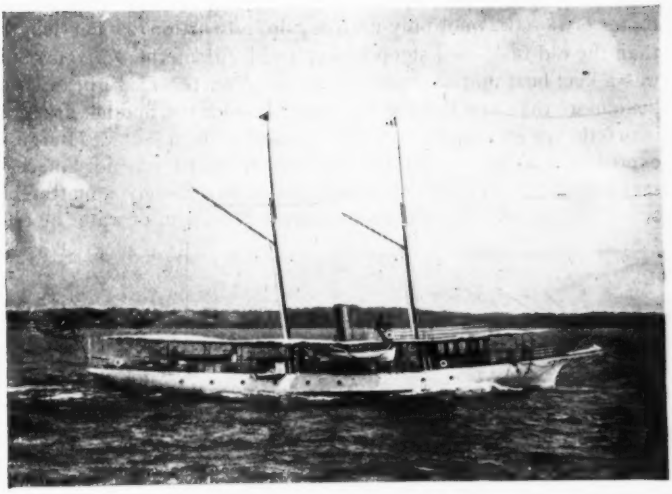
*Thistle* is a gratifying result of a departure from the old [English] beam-compressing rule and the fore-runner of a new type of cutters, Americans have been moving (to a less extent certainly) toward a narrow type of sloop, and have adopted the cutter rig with various modifications which have approved themselves. Ballast is now put as low as possible, and our yachts are given greater displacement than formerly. It can no longer be said that American boats are dangerous 'skimming-dishes,' for the new ones are good, wholesome, non-capsizable boats, able to take their chances in all kinds of weather."



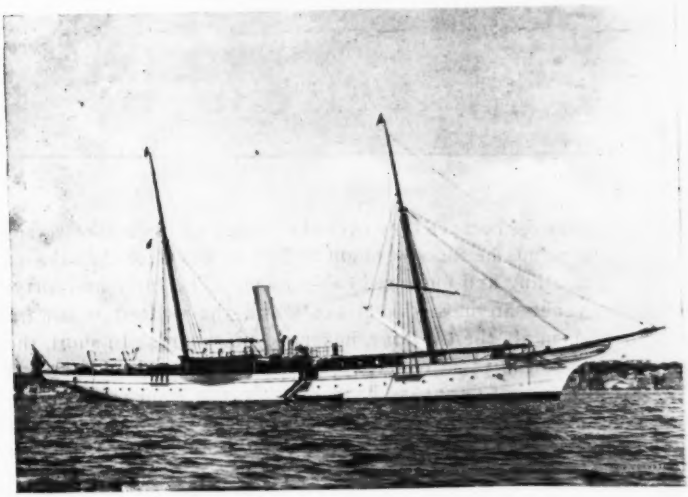
ELECTRA, ELBRIDGE T. GERRY OWNER.



ALVA, W. K. VANDERBILT OWNER.

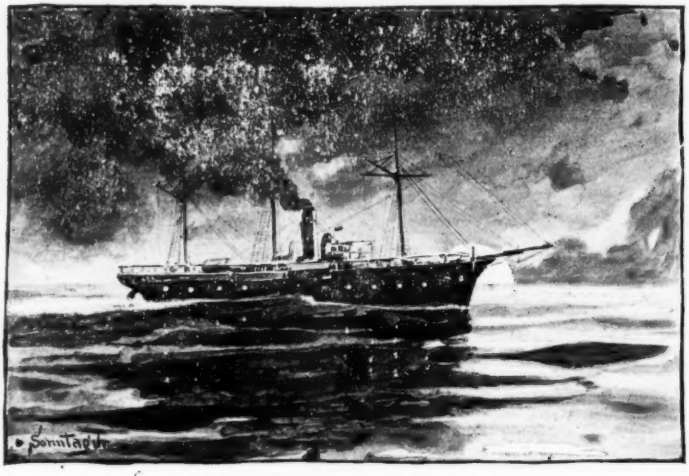


LURLINE, W. BOERUM WETMORE OWNER.



CONQUEROR, F. W. VANDERBILT OWNER.

If Mr. Burgess's words were true when they were printed in 1888, they have even greater force now, for the typical forty-six footer of 1891 was not only narrower in proportion to her length than the old-fashioned sloop (though wider than the *Puritan*) but was a keel boat and uncommonly deep. The *Gloriana's* beam is a little more than one third of her water-line length, and her draught is two inches greater than the *Volunteer's*. In 1888 Mr. Burgess expressed it as his opinion that the center-board was not a necessary factor in successful windward work, but merely a matter of convenience. For big yachts drawing a good deal of water he ad-



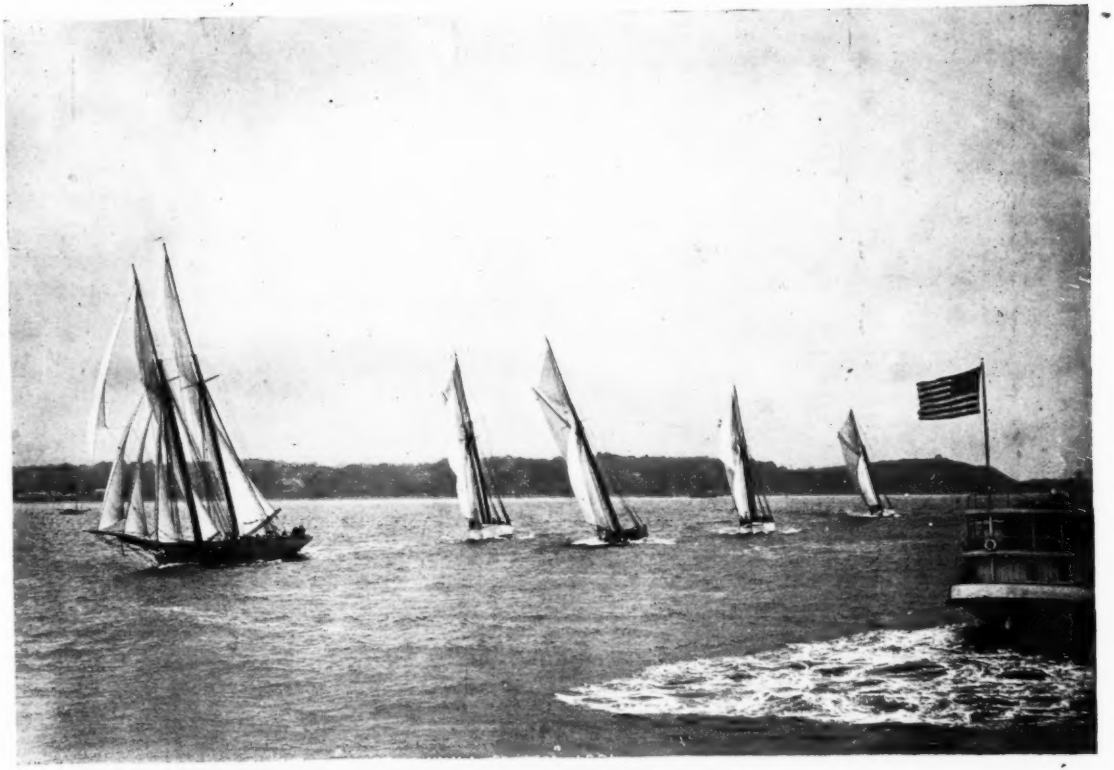
ATLANTA, JAY GOULD OWNER.

vocated boards, because they could be hauled up in shallow water; but small yachts he thought ought to be keel boats for the sake of ease in handling and increased cabin room. The forty and forty-six foot yachts are mostly keel boats, and the swiftest windward craft of them all, the *Gloriana*, has no centerboard. In short, the typical American yacht of to-day is a rather beamy keel boat. It is undeniable that designers have recently run somewhat wild in their search after "power," and have turned out yachts whose chief aim seemed to be the development of ability to carry enormous sail spread. But these same vessels, put under reduced cruising rig, would be far safer to cross the ocean in than the fa-

mous forty-footer *Alice*, which made the trip something like a score of years ago. I have seen the *Baboon* out in weather which put schooners like the *Sachem* under housed topmasts, reefed mainsail, no foresail, and a jib, going to windward like a duck under housed topmast, reefed mainsail, staysail and jib. And the *Oweene's* performance in the New York Yacht Club's thrash from Huntington Harbor to New London in half a gale last summer, when she fairly ran away from all the big vessels except the *Katrina*, will ever be a memorable lesson. In fact as the owner of a typical thirty-footer once said to me : "Reefed close and with hatches down I can stay

DAUNTLESS, CALDWELL H. COLT OWNER.

out as long as a ship. The only danger is that of being washed overboard." And as for stability I can say that I myself purposely sailed this same gentleman's boat eight points off the wind with her boom flat aft in a stiff breeze. She went down on her beam ends ; but the moment I eased down the helm, she came up like a duck. Yachtsmen will smile at my taking the trouble to mention these things ; but the non-yachting man is still laboring under the delusion that sailing is the most dangerous of sports, whereas with our new craft it is one of the safest.



START OF NEW YORK YACHT CLUB REGATTA, 1891.

Among the crack yachts which belong to the harbor of New York the first in importance is certainly the wonderful forty-six-footer *Gloriana*, owned by E. D. Morgan, designed and built in 1891 by N. G. Herreshoff, of Bristol, R. I. The Herreshoffs had always been known as designers of swift steam yachts, but hereafter "Nat" will rank with Burgess as a modeler of sailing craft. The *Gloriana's* record is too fresh to need repetition. She sailed in about twenty races and never was beaten, while her time, and that of her competitors, too, showed that they were all faster than seventy-footers of fifteen years ago. I take the liberty of quoting from an article of my own in an English paper: "It is true that the *Gloriana* is a new type, but she is the result of direct development. Her sheer plan is certainly an outgrowth of the *Thistle's* visit to the United States. She is cut away forward as the *Thistle* is, and her greatest draught is a few feet ahead of her sternpost. Her bow is longer than the *Thistle's* above water (in proportion to her size, of course) and there is no break in the line running from her gammon iron to her keel. She has no forefoot at all, and this peculiarity gives her a strange appearance. Her sternpost shows less rake than those of the forty-footers built in 1890, and her forebody is perhaps a trifle longer. But the most important feature of

Edward C. Burgess

the yacht is her water-lines. Her designer has discarded all concavity forward, thereby carrying out a line of development along which Mr. Burgess was certainly moving. The Burgess yachts of 1885 show a decided concavity in their water-lines forward. The later boats of this designer, however, have approached straight lines. Mr. Herreshoff has simply returned to the old theory of convex lines, a movement which it seems likely Burgess would have made very soon if he had not been cut down by untimely death. The *Gloriana's* bows flare out strongly above the load water-line, and in butting a sea she has very fussy action, splashing the water out from under her lee bow in clouds of spray fifty or sixty feet wide. But although this gives her the appearance of piling the water up in front of her, it really has no effect on her speed. She is so shallow forward that she seems to slide over the surface rather than cut through the seas. She carries twenty-three tons of lead in her keel, and her sail-spread is 250 square feet greater than that of her nearest competitor in this particular." E. D. Morgan, the owner of the *Gloriana*, is one of the most enthusiastic and skillful of New York's yachtsmen. He owned also until recently the magnificent steel schooner *Constellation*, 131 feet over all, 106 ft. water-line, 24.9 ft. beam, 12.3 ft. draught, designed by Edward Burgess and built by Henry Piepgras at City Island in 1889. Mr. Morgan sailed her himself in a masterly manner.

JAMES GORDON BENNETT.

A typical New York forty-footer is the keel sloop *Liris*, owned by C. W. Wetmore. Her dimensions are 57 feet over all, 39 ft. 9 in. water-line, 13 ft. beam and 9 ft. 10 in. draught. She was designed by William G. Gardner, of this city, and built by Samuel Ayres in 1889. In the thirty-foot class one of our typical flyers is William Whitlock's *Kathleen*, 42 ft. 10 inches over all, 29 ft. 10 in. water-line, 10 ft. 6 in. beam, and 6 ft. 11 in. draught. She was turned out in 1889 by the designer and builder of the *Liris*. These two yachts are distinguished by their immense power.

The three seventy-footers, *Titania*, *Katrina* and *Shamrock*, have done less racing in the last year or two than they formerly did, but no account of New York yachts would be complete without mention of them. The *Titania* is a steel centerboard cutter (called a sloop)

designed by Edward Burgess and built by Henry Piepgras in 1887 for C. O. Iselin, who still owns her and sails her well. Her dimensions are: Length over all, 81 ft. 6 in.; water-line, 69 ft. 11 in.; beam, 21 ft.; draught, 8 ft., 1 in. She was one of the first yachts in which the complete cutter rig, including the reefing bowsprit, was adopted, and was also one of the first steel yachts built in these waters. She has a notable racing record, having achieved especial distinction in brisk winds and strong seas. The *Katrina* belongs to E. S. and H. D. Auchincloss. She was designed by A. Cary Smith, of New York, and built (of steel) by Piepgras in 1888. She closely resembles the Scotch cutter *Thistle* in profile above the water and is one of the handsomest vessels afloat. Her dimensions are: Length over all, 86 ft. 6 in.; water-line, 69 ft. 4½ in.; beam, 20 ft. 4 in.; draught, 9 ft. 3 in. She has a fine record, and is at her best in smooth water with good breezes. The *Shamrock* is a wooden craft and has the distinction of having been designed by her owner, J. Rogers Maxwell, an amateur sailor who has probably no superior. She was built by J. F. Mumm in 1887 on the following dimensions: Length over all, 80 ft. 3 in.; water-line, 69 ft. 11 in.; beam, 19 ft. 7 in.; draught, 8 ft. 5 in. She is a remarkably fast boat in light winds and smooth water, but her power is not great enough to make her a sail-carrier in stiff weather. I have always thought that much of her success was due to Mr. Maxwell's superb handling.

ELBRIDGE T. GERRY.

E. D. MORGAN.

A representative New York craft, one of the most famous in America, and a brilliant example of the best qualities of the old shallow type, is the centerboard schooner *Grayling*, owned by Latham A. Fish, one of the most accomplished yachtsmen who ever trod a quarter deck. She is what is known as a "rule o' thumb" boat. That is, she was not designed according to scientific calculations, but by mere judgment aided by experience. Her designer was Philip Elsworth and she was built by C. & R. Poillon in 1883. Her di-

mensions are: Length over all, 91 ft.; water-line, 82 ft. 8 in.; beam, 23 ft.; draught, 5 ft. 9 in. She is a very swift boat in all ordinary racing weather, and has held her own with the best of the later products.

The best known steam yacht in New York is the *Alva*, W. K. Vanderbilt's magnificent vessel. She is a steel vessel, bark-rigged, designed by St. Clair Byrne, of England, and built by the Harlan & Hollingsworth Company, of Wilmington, Del. She is 285 ft. over all, 252 ft. water-line, 32 ft. 3 in. beam and 16 ft. 8 in. draught. Her engines are of the compound inverted type with two 45-inch and one 32-inch cylinders. She has been around the world and is a frequent cruiser in foreign waters. The steam yacht *Electra*, flagship of the New York Yacht Club, owned by Commodore Elbridge T. Gerry, is perhaps better known to yachtsmen, though not to the general public, than the *Alva*. She is 174 ft. over all, 161 ft. 6 in. on the water-line, 23 ft. beam, 9 ft. 6 in. draught, and can steam about 13 knots per hour. She was designed by G. Hillman and built by the Harlan & Hollingsworth Company in 1884. She is a fair sea boat. She carries a propeller 8 ft. in diameter and 13 ft. pitch, making as high as 160 revolutions. Her engine is of the inverted, direct-acting, compound type, with a high-pressure cylinder 22 in. diameter, low-pressure cylinder 40 in., and piston stroke of 26 in. Her boilers are two, each 11 ft. long, 10½ ft. in diameter. In addition to her propelling machinery she carries engines for running a dynamo to supply 58 Edison lights of 16-candle power each for interior lighting, a 100-candle power masthead light, and sidelights, as well as an ice machine producing 56 pounds a day, an independent condenser, independent pumps, and an independent fire and bilge pump. Taken all in all she is a model craft, and deserves her fame.

# THE PURIFICATION OF WATER.

*By Floyd Davis, E. M., Ph. D.*

THE object which should be sought in thorough purification of city water-supplies is softening and clarification of the water for manufacturing and boiler use, and removal of such organic and infectious matter as may produce or even promote disease. The substances to be removed may be in suspension, such as finely-divided clay, silicious and calcareous matter; soluble salts of lime and magnesia that harden water; and decaying organic matter and micro-organisms. The latter are the most important substances to be removed from drinking-water, since many zymotic diseases are produced by infectious germs that gain admission to the system through sewer-contaminated water. This article is written especially to present some of the ways by which nature removes most of these substances; but a few of the chemical principles involved in artificial purification of water for city supplies are also briefly discussed. The application of these principles will be given in a future paper on "Water Supplies for Cities and Towns."

Mountain springs and streams are generally quite pure, being free from infectious matter. This may in part be due to oxidation and action of sun-light, for chemical changes are slowly effected in swiftly-running water by rapid and violent admixture of atmospheric oxygen, and by chemical rays of the sun. This is one of nature's processes for aerating water. Some organic substances easily disintegrate in the presence of oxygen, while others, like muscular tissue, may remain in water for months and still be recognizable under the microscope. These changes take place in streams most rapidly in summer, when the temperature is highest and the admixture of air is greatest; while in winter the changes are slow owing to the low temperature and the ice formations that shut out the air and light. But it is certain that there is an overestimate put upon oxidation as a natural agency of purification, and there is no experimental evidence to show that streams are purified to any great extent in this way. The purity of mountain springs and streams is not owing so much to any process of purification as to their original freedom from contamination.

The mineral constituents of streams are, however, often re-

moved by chemical processes. Thus the Schuylkill River, which receives the drainage of mines in its upper course and is charged with iron salts and free mineral acids, becomes comparatively soft and pure before it reaches Philadelphia, which city is supplied with its water. This river flows through an extensive limestone district and receives water from other streams charged with calcium bicarbonate. The commingling of these acid and limestone waters removes the mineral constituents from each, by precipitating gypsum along the river banks; and as the subsidence takes place much of the organic matter is also mechanically removed from the water.

Impure streams that flow through rich agricultural and densely-populated regions are apparently purified by dilution, from springs along the banks and the inflowing smaller streams of less impure water. The by-products of chemical factories that are thrown into streams, and which are neither removed by chemical action nor by sedimentation, are frequently so diluted in a few miles flow that the water becomes harmless, although at the factories it may be a strong antiseptic. Streams become purified to the greatest extent, however, by a process of sedimentation, which, in its origin, is largely influenced by chemical action. This takes place as the velocity of the current diminishes, when much of the insoluble matter subsides, removing with it organic matter that would remain in suspension or solution for many days. Along slowly running streams can be seen in summer organic accumulations on stones laid down by sedimentation. A careful study of the various natural processes of purification has led Dr. Percy F. Frankland, of England, to the conclusion that not only is sedimentation the principal cause of the natural removal of decaying organic matter from river water, but that it is also the principal cause of the partial disappearance of germs. The latter is of great hygienic importance in both natural and artificial purification of water.

But nature does not completely remove organic matter and micro-organisms from river water. The distance required for a reasonable separation of the former in our American streams is generally not more than fifteen or twenty miles, and often much less. The Hudson River, which receives the sewage of Troy, becomes reasonably free of its organic matter in the six or eight miles flow to the city of Albany. But owing to the small size of some English streams, like the rivers Severn, Tees and Wear, and the great population on their banks, the waters remain unfit for use many miles

below the points of contamination ; and the Royal Commissioners concluded that there is not a river in all England sufficiently long to free itself through natural agencies of even a moderate amount of sewage. The self-purification of water in streams is no guarantee that it is wholesome at any distance below the place where it is certainly contaminated with products of the human body, for although the organic matter and even the germs may be largely removed, it is unsafe to drink water for any length of time that contains even a few infectious bacteria. When river water has once been polluted with excrementitious washings from diseased patients, it should never be used directly or from city water-works without due consideration of its nature, and the possibility of its producing disease.

Nature also purifies water to a considerable extent in freezing, and the product deserves our attention for there is a rapidly increasing demand for ice in the United States, where we are already cutting some 25,000,000 tons annually. Those who frequently examine ice and have followed Tyndall, Cramer, Leone, Fraenkel, Engelmann, Pengra, Prudden and others in their investigations know that water is only partially purified in freezing. The freezing process removed for Pengra only from 20 to 50 per cent. of the organic matter, 40 per cent. of the inorganic salts and about 90 per cent. of the micro-organisms. The diminution of bacteria in water in freezing is owing largely to their destruction instead of expulsion. But some species of bacteria have great power of withstanding cold, and the bacillus of typhoid fever has been found in ice several months after its formation ; and there are many other classes of germs that cannot be destroyed by freezing alone. When such impure ice is melted the living germs regain their activity, and if pathogenic, are capable of producing disease. Impure snow water is also sometimes detrimental to health. Some years ago Dr. Charles Smart, of the United States Army, traced the cause of mountain fever to the melting snow of the Rocky Mountain streams, and inferred that the germs of this typho-malarial fever were brought down from the atmosphere by snow, remained frozen during winter, and then passed into the streams in an active condition when the snow melted in May, June and July. It is frequently the case that impure ice is the agent of transmitting typhoid and other fevers.

The extent of purification in freezing seems to depend largely upon the nature of the ice formed, for clear ice generally contains

less bacteria than white or snow ice. This is owing to the fact that aerial germs usually gather around air bubbles in water and are entrapped in the ice *in situ*. Ice is too frequently gathered from sewer-polluted streams below large cities, where impurities are constantly washed in upon the layers of ice and frozen with it. It is easy to understand why such ice contains imprisoned in its apparent crystalline and transparent mass nearly all of the putrid organic matter and dead or living germs of the water itself. It is a safe rule, and one which should always be observed in making a selection, that ice formed on polluted water is generally unsafe to use, and that no ice should be used for household purposes in contact with drinking fluids, except that made from the purest water. In some of the southern cities artificial ice has forced much of the natural product from the market on account of cheapness. In making artificial ice care should always be exercised in securing the purest water possible, as in most machines the entire water is frozen and no impurities can escape. Natural ice is, therefore, always superior from a hygienic standpoint to the artificial product formed from the same water. In some factories distilled water only is used for making ice, in which the purest product is formed ; and one company in Washington City uses the excellent motto : " Freezing does not kill bacteria ; distillation does."

There are great economic advantages in supplying a city with soft water, free from mineral acids. A water that carries an abundance of hardening or acid salts or free mineral acids is always expensive to use in generating steam, as the boilers require constant attention, frequent repair and extra coal. And experience shows that it is always cheaper in the course of time to use a pure natural water or to purify other water before it is used in boilers. A very soft water is also required in many manufacturing establishments, like starch works. But the most important consideration in using a soft water for a city lies in the saving of soap. A soap has no detergent effects until it has removed the hardening salts of lime and magnesia from the water. It is estimated that the city of Glasgow saves 36,000 sovereigns per annum in the use of soap, since 1859, when her water-supply was changed from the hard water of the Clyde to the soft water of Loch Katrine. When artificial purification is resorted to in cities supplied with hard water, we believe there would generally be a great economic advantage in softening the water. Clark's process has been most extensively adopted in England for this purpose. This consists in adding milk

of lime to the water in extensive settling basins until all of the carbonic acid is neutralized, when the hardening salts and the lime added are all precipitated as normal carbonates. As the lime precipitates it removes much of the organic and coloring matter and micro-organisms that may exist in the water. To avoid expensive settling basins and the time required for clarification, a modification of this method, known as the Porter-Clark process, is in use. In this the precipitate is rapidly separated by means of a filter-press.

The natural method of purifying ground-water and which we imitate in our artificial systems is filtration. In this, nature removes infectious organic matter by biological agencies, but there are certain mechanical and chemical changes that are effected by filtration alone. It may be laid down as a general rule that nearly all natural waters may be improved by filtration while none can be injured by the process; but whenever an artificial filter is used it should be so constructed as to be easily and frequently cleansed and aerated, that none of the impurities removed at one time may be washed into the water at another. It is estimated that the surface areas of the particles of a cubic foot of fine sand amount to many thousand square feet, and the larger the area the more thorough the filtration.

Mechanical filtration, whether natural or artificial, assists in purification in at least three distinct ways. First, by straining, in which the efficiency of the operation depends on the fineness and nature of the sand, and rapidity in flow of the water. White, angular, quartz sand is generally used for artificial filter beds on account of the ease with which it can be cleansed. Owing to the rapidity in flow, no pressure filter can strain water as thoroughly as it is done in gravity systems. Straining is the principal way by which the solid, coagulated and entrapped impurities are removed in any filter bed used for city water-supplies. Second, by sedimentation and adhesion within the pores of the filter, and the efficiency here depends upon the size of the sand particles and rate of filtration. Third, by oxidation and other chemical action. The accumulations on the extensive surface areas of the sand particles furnish great opportunity for the ground air to destroy the organic accumulations; and it is evident that this is done as the oxygenated water flows slowly through the film-coated sand particles. On the other hand charcoal condenses oxygen in its pores, and destroys the organic matter of water as it passes through it, and it absorbs

foul gases from water, but it soon gives up its oxygen and loses its power of condensation unless frequently cleansed and reburnt. According to Salamon and Matthews, coke owes its power of removing organic matter from water to the iron contained in it. Any filtering medium, whether natural or artificial, should be thoroughly supplied with oxygen, which element is always present in all perfect filter beds. Without it there can be only a temporary oxidation of impurities in water.

The surface soil of the earth is the great natural purifier of ground water. Here nature provides for the change of noxious into harmless compounds as the water passes through the first few feet of soil. When sterilized soil or sand is used as a filtering medium the water that passes through for the first few days may be thoroughly clarified, but it will be only slightly improved by removal of organic matter. At first the water retains all its micro-organisms, or their number is increased as it passes through the filter. After a few days all this changes. The sand spaces near the surface become filled with a light bacterial slime, that not only forms a nidus for the germs to accumulate and breed in, but it soon acts as an almost perfect filter for entrapping other bacteria that are on their way downward. The water that passes through will under favorable conditions be almost sterilized. Some of the micro-organisms thus caught soon die in the filter ; but the great majority of the water bacteria produce this slime in the soil and in it find a paradise for their work. They live in these surroundings with the decaying organic food flowing by them that they require to thrive on. They have an upward movement in the soil, and tend to accumulate near the surface or in the four or five feet of surface soil. Here they slowly tear asunder the organic matter that flows downward, appropriating a portion of it to their own economy, while the remainder is set free for other classes to work over into new and harmless compounds. One class of bacteria transforms the nitrogen into ammonia ; another class oxidizes this ammonia into nitrous and nitric acids ; while another class converts some of the carbon into carbonic acid ; and much of the organic matter is so modified as it passes through the soil that the roots of living plants absorb and assimilate it. These changes of nitrification are among the most important chemical changes effected in nature. The removal of harmful impurities from water in the soil is, therefore, primarily more of a biological than a chemical question ; and in considering natural purification of water we must ascribe to mi-

cro-organisms the rank of first importance, although some of them may be infectious. The changes which they effect in purification of ground water are more perfect than can be effected in artificial systems of purification, and hence we must expect to find our purest water in the soil where nature has oxidized and removed the impurities from it. For this reason we believe there is generally no source of water of sufficient extent so pure and desirable as properly-selected ground water, and no system for city supplies more deserving consideration than the ground water system, when the water can be secured out of range of contaminating influences.

The slow and intermittent nature of filtration through soil is an important element in the efficiency of this work. In seasons between rains the soil becomes thoroughly stored with ground air and carbonic acid. These are the aerating agents of the next fall of rain after the bacteria have done their work near the surface of the ground. In imitation of this, artificial aeration is frequently resorted to in water works to complete the destruction of some of the organic matter that cannot be coagulated and removed on filter-beds. So we have learned to follow nature in various ways in the great work of purifying water, and the most perfect artificial systems are those that imitate her best in this work.

In the artificial purification of water, various methods have been adopted for the removal of soluble organic matter and germs. Ferric chloride, potassium permanganate, and some other oxidizing agents have been used to destroy this organic matter, but the substances now most successfully used are coagulants. These precipitate the soluble organic matter, which in turn removes most of the germs as it is separated from the water by proper filtration, and in the best systems the water is finally improved by aeration. Alum has been in use for centuries and it and aluminum sulphate are the commonest agents now used. It is very probable that salts of alumina contained in the soil have a marked influence in coagulating organic matter and therefore in purifying water. With waters containing considerable salts of lime, these reagents act in a beautiful way. The lime is precipitated with the sulphuric acid of the alum or aluminum sulphate, as gypsum, while the alumina is converted into a flocculent hydrate that coagulates and removes with it the soluble organic matter and the bacteria. From laboratory experiments we have found it easy to remove with alum more than 60 per cent. of the organic matter and at least 99 per cent. of the bacteria

from water. The amount of these coagulants required is usually very small, depending somewhat on the lime in solution, and ranges generally from one-tenth to two or three grains per gallon of water. When the amount is properly regulated the alumina is so perfectly removed from the water that the most delicate chemical tests fail to reveal even a trace of it. Under proper management alum and aluminum sulphate can never be injurious in water. They are the precipitates generally used by such filter companies as the American, National, Hyatt, Jewell, and some others.

The removal of organic matter and germs by agitation with metallic iron, as practised in Anderson's revolving purifiers, is also a very successful method of purification. The iron is here converted into a bicarbonate, which when exposed to the air oxidizes and precipitates as hydrated ferric oxide, carrying with it much of the organic matter and bacteria, which are finally removed by filtration. It should not be understood, however, that any artificial method for purifying city water supplies has ever completely removed the organic matter or all the germs. This can be done only by the slow processes of distillation or sanitary filtration; and no contaminated water should be used for drinking without first being boiled or passed through a sanitary filter to remove the infectious germs. But the processes for city supplies aim at coagulation as a preliminary means of removing infectious matter from water. The balance of the work depends upon filtration, which in any artificial system is little more than a mechanical process. Its efficiency depends largely on the filtering medium, rapidity of filtration, and care exercised in keeping the filters thoroughly clean.

# THE FRANKLIN STATUE.

*By Young E. Allison.*

THE colossal statue of Benjamin Franklin which is to mark the main entrance of the Electrical Building at the Columbian World's Exhibition is completed and is attracting wide attention and admiration. The photographs that have been made of the model suggest the force and breadth of a conception which has lost nothing in the execution. There is in the work a concentrated power so often seen in the rough sketch, yet which the most patient artist finds it difficult to preserve in the finished figure. The sculptor of this Franklin statue is Carl Rohl-Smith, a Dane by birth, who, after studying and pursuing his career in all the capitals of Europe, with success, came to the United States a few years ago to become an American. This, his first great public work, demonstrates that he has understood with intuitive appreciation the spirit of our history and achievements. Rohl-Smith left in Europe many specimens of his peculiar genius for treating sculpture on a colossal scale, as applied to architectural compositions and to great public works. In the ornamentation of the New Parliament House at Vienna and of the beautiful marble church at Copenhagen, besides in the adornment of parks and public places in Denmark and Germany, he had important place. His chief work, an Ajax, was in the Royal palace at Copenhagen and was lost in the fire that destroyed that building some years ago; but there are many works in the galleries of Europe from his hand.

After his arrival in the United States, besides innumerable basso-relievos and busts of public men such as Henry George, Henry Watterson and others, he executed two public works, before the Franklin statue was begun. One of these was a monument to Judge Richard Reid, of Kentucky, the Superior Court judge whose tragic death a few years ago is one of the most thrilling chapters of the history of that State. The other was a heroic figure of "The Defender of the Alamo," to surmount the Alamo monument that has been erected by the State of Texas at Austin. A number of private monuments and portrait figures of heroic size have also been produced and adorn cemeteries in Memphis, Louisville and Boston, forming an agreeable and artistic contrast to the

dull monotony of ready-made designs that usually serve to render an American cemetery common-place and objectionable to an eye trained to seek beauty.

The statue of Franklin, however, may be fairly set down as Rohl-Smith's first great public work in America, inasmuch as the design itself, the spirit of the idea, was left to him, with the added advantage of executing it upon a colossal scale. It is fourteen feet in height, and as yet is cast in plaster, though the Chicago papers have intimated that some of her millionaires propose to have it cast in bronze, and, when the fair closes, add it to the growing number of Chicago's art treasures.

The figure represents Franklin, with his kite and cord in hand, in the midst of a gathering storm, watching for the moment when he was to send that kite up and bring down from the flashing skies the brilliant and important message to science that lightning was identical with the electric fluid. It requires no effort to see that the sculptor has rendered the idea in a most graphic and dramatic and yet in a perfectly simple and natural manner. There is the mark of the storm in the blown drapery and locks; there is the look of keen and eager suspense in the face, and the figure is poised at the moment of intense mental and physical activity in repression. There are few sculptors who have, in anything like the degree possessed by Rohl-Smith, the capacity to represent intense action without straining. It is an element of his genius apparent in almost every work he has executed; but it is when observed in such a great figure as this, that its admirable quality can best be judged. It lends a stirring realism to the effect, and produces an impression at a glance which no amount of closer study can obliterate. There is no rest in it, yet there is no strain; he has caught the well poised and critical instant when intellectual propulsion is about to manifest itself in physical effort. And this is the poise that sculptors dream about and few achieve. There is, moreover, in the work a triumph over the classical idea that the sculptured figure or group must be complete in itself without exterior objects contributing to the "story," on the theory that such contributing objects must be pointed out, and their absence therefore detracts from the work.

With "Franklin" written under Rohl-Smith's statue even a school-boy might tell the story and see without suggestion the flashing clouds into which the eyes are peering with the desire to drag their secret to earth. There will be no art work of a realistic

character at Chicago which will surpass this statue of Franklin. It is the best representation by art that has yet been made of that homely old anecdote of how the blunt philosopher "drew the lightning from the skies," and Rohl-Smith has rendered it with epical suggestion.

# CIVIL ENGINEERING.

ETHICS in the Engineering Profession was made the subject of an excellent editorial in a recent number of the *Engineering and Mining Journal*. While the "standard of ethics" is held to be "far above what it was some years ago," there are, in the opinion of our contemporary, "some old abuses which are still largely practised, though rigidly discouraged by the better members of the profession." Among these the acceptance by engineers of commissions on goods or work purchased or done for those who pay them for their services, is named as the principal abuse to be deprecated, as it is the one most practised. Our contemporary points out that the acceptance of such commissions is a "breach of trust and a fraud upon employers." It does not add that this view has been sustained by the courts, but such is the case. Now, can it be possible that any notable number in this honorable profession are willing to commit deliberate fraud? Our contemporary says: "No one questions the right of an engineer to act openly as the agent for a manufacturer and to receive his remuneration in a commission on the goods sold, but this is a very different case from that of the employé of a company accepting a commission. Every salaried employé, whatever his position, whether president, engineer, superintendent, purchasing agent or in any other position in which he has undertaken to give his services, owes to the employer his very best service, and if in making purchases he can secure a reduction in cost, that is a part of the service for which he is paid. If then he accepts a commission and applies it to his own use, *i. e.*, does not turn it over, he is defrauding his employer just as much as if he gave to another a portion of the time for which he is paid, or as if he took so much of his employer's money out of the till and appropriated it to his own use." All this is true, but is it a criticism called for by an evil of substantial importance? It may well be questioned, since no facts are stated that corroborate the assertion. It may be admitted that the evil exists to some extent, but the writer believes it to be a fast diminishing one that will ultimately become extinct under the influence of the numerous and increasing engineering clubs and societies uniformly tending to raise professional ethics to the highest plane.

The Third Annual Report on the Statistics of Railroads in the U. S. by Henry C. Adams, Statistician of the Interstate Commerce Commission, represents an immense amount of labor and contains information of great value. Anything like an adequate notice of this report would occupy more space than can be afforded for it here, and the excellent article "Decline in Railroad Building," by Mr. Thomas L. Greene, in our February number, gives so much general information relating to railroads and the present status of railroad construction, as to render it unnecessary to more than glance at the general character of Mr. Adams' work, more particularly as all the papers specially devoted to railroad interests, as well as daily and weekly papers not so devoted, are printing liberal extracts from it. In the first place, these reports may be said to supply a pre-existing want for uniform and trustworthy statistics, in so full and complete a measure, and so admirably arranged for reference as to leave nothing further to be desired. The railroads of the country are divided into ten territorial groups, by which a comparison of figures for different sections of the country is very easy, and the relations of density of population, kind and amount of production, conditions of climate, natural resources, etc., to railway operation can be conveniently studied. The total railroad mileage in the U. S., on June 30, 1890, is given as 163,597 miles distributed among 1797 corporations, 735 of which have leased their roads to other corporations, leaving 927 companies actually operating the roads. Forty of these companies op-

erate nearly one-half (47.51 per cent.) of the entire mileage, these figures showing very forcibly the modern tendency to centralization of capital in large enterprises. The total number of men employed is 749,301, an average of something more than 4¾ to each mile. There are 8384 passenger locomotives, 16,140 freight locomotives, 26,511 passenger cars, and 1,137,677 freight cars, or nearly 7½ cars to each mile of road. The amount of capital invested is $9,437,353,372, an average of $60,340 per mile. The net earnings foot up $359,783,661, or $2301 per mile.

"The Polar Planimeter," a manual by William Cox, New York, is a recent treatise which gives a description of the polar planimeter with engravings illustrative of the instrument. It tells how to use the instrument to determine the value of the wheel vernier unit, how to obtain settings with the trial disc, and it also gives formulæ for obtaining settings by computation. Full directions are given for the use of the instrument in determining the area of large surveys, wherein the placing of the planimeter within the drawing is necessitated. At the end of the pamphlet is a resumé of all equations used in the treatise, and this is followed by appended tables which give a list of the different scales usually employed for working drawings of machinery, buildings, etc.; plans of surveys, railways, canals, etc.; with the absolute value of the wheel unit; the value assigned to the wheel unit as compared with the scale of the drawing; the number of wheel units registered by one complete unit of the trial disc for areas of from 2570 to 2630 square millimetres or their equivalents, 3985 to 4075 square inches; and, finally, a list of approximate settings which will materially assist in finding the exact setting for any scale. This manual should be at the elbow of every draughtsman.

Interesting Statistics of Railway Construction for the year 1891 are given in the *Railway Age*. From the summary therein contained it appears that 4282 miles of track were laid in the United States, this construction being distributed among 286 different lines. Of this total, 1383 miles were laid in the Southern States, Mississippi alone making no increase. Railway extension is thus shown to have been, in the Southern States, nearly double that in the New England and Eastern group, in which West Virginia is included, the track laid in this group having been 774 miles.

The Experiment of Broad Gage may be said to be fairly ended by the narrowing of the gage of the Great Western Railway (England) to the standard gage. Preparatory to this expensive change, it is said that about twenty miles of siding have been constructed to accommodate the rolling stock that must be taken off from the line. This rolling stock will not cease to be a white elephant by merely placing it on sidings; its subsequent disposal will entail great expense and trouble upon the management of the road. In no department of engineering has the law of evolution been more conspicuous in its operation than in railroading. In the survival of the fittest the standard gage remains against all competitors, and one recalls with some amusement, as well as interest, the voluminous and sometimes rather acrimonious discussion of the subject in the "seventies," called, at the time, the battle of the gages. The narrow gage still survives, but only for special work; it, too, had advocates who thought it advantageous for general traffic; but these views are also extinguished. The standard gage is here to stay.

The Revolution Wrought by High Explosives was referred to in our February number in a paragraph stating the wonderful economy attained in getting out rock in New Jersey with nitro-gelatine. In its issue of January 16th, *Engineering News* printed an article of over four columns, ably discussing all the phases of tunnelling in soft ground. Among many other interesting features of modern tunnelling, it mentions that since the advent of high explosives, they have reduced the cost of tunnelling in rock to a figure below that of penetrating soft ground. "At the present time," says the article referred to, "tunnelling through hard rock, free from seams and faults, can be carried on with such certainty and dispatch that, if we take into account the cost of lining, a

tunnel can probably be built far more cheaply through it than through any other material, though the solid rock has always had some slight advantage. The apparently easy task in tunnelling is now more than ever the most difficult. The softest and apparently most easily removed materials now offer by far the greatest obstacles to the engineer. But it appears to be true that a large proportion of our tunnels will, in future, be made through these materials." This last statement is made with reference to the great success that has attended the use of the hydraulic-shield system of tunnelling, the last crowning achievement in subterraneous engineering.

A New Quick-firing gun is said to have been so far perfected by M. H. Schneider at Creusot, that it will soon make its appearance in official tests. The calibre is said to be 15 cm, and the length to be 45 calibres. The cartridges being of unusual length, some difficulty has been met in manufacturing them; otherwise it is stated the gun would be now ready for testing. M. Schneider has stated to the French Ministry, that even with imperfect cartridges, and a projectile weighing 40 kilos, he has attained an initial velocity of 820 m., the rate of firing being once in 7½ seconds, and the gas pressure 2500 atmospheres. The rate of firing is expected to be increased to once in 6 seconds (with the perfected cartridges) with an ultimate initial velocity of 880 m. The mechanism of the gun, including that of the carriage is of a new type, and both the gun and its carriage are stated to be very simple and strong. It is claimed, moreover, that the recoil is moderate, and that the line of sight is not materially affected by it.

"Good Roads" is the name of a new monthly publication devoted to reform in road making and road improvement, that made its advent with the new year. It is neatly printed, beautifully illustrated, and filled with good matter, ably edited by Mr. Isaac B. Potter, who is to the cause of road reform in this country what General Booth is to the movement in England for bettering the condition of the population of London slums; that is to say, he may be considered, as heart and soul devoted to the cause, and the foremost leader in it. Our readers will recall his contribution on this subject to the pages of this magazine. His name will at once accredit the new magazine, and as it is published by the League Roads Improvement Bureau, and is announced as the property of the League of American Wheelmen, it will be the official organ of the League. The publication invites the co-operation of all good citizens who favor the move for improved highways. The first number contains "The Gospel of Good Roads," by the editor; "National Highways," by Albert Mott; "The Personal Labor Tax System," by Casper Taboit: Railroads and Wagon Roads; Editor's Table; A department of "Laws and Legislation"; another of News and Comment, and still another, of humorous character, headed "Borrowed Wit." This venture, successfully launched, will almost certainly make many pleasant and prosperous voyages across the years to come.

The Engineer Corps of the U. S. Navy, is stated by Engineer-in-Chief Geo. W. Melville, in his annual report for 1891, to be very deficient in number. On this account he represents the corps as badly overworked, and notwithstanding all efforts to perform its duties adequately, to be totally unable to properly perform them. He expresses the fear "that the conditions which obtain with modern high-power machinery, and the duties which come upon the officers charged with its maintenance, are not thoroughly understood by Congress, and in his report goes somewhat into an explanation of these duties. He calls attention to the "nervous strain which must come upon conscientious officers too few in number to give proper attention to details, but fully aware of the risk which is incurred. They go on with their work as faithfully as they can, but in constant dread of an accident for which they feel they should not be held responsible, but for which they may be made to suffer the implied disgrace of a trial by court-martial, or the imputation of neglect of duty." In proof of his contention he cites the case of a collision "directly traceable to lack of sufficient en-

gineer officers. One cause of this insufficiency is named as being the practice of detailing engineer officers as instructors in technical schools and colleges," wherein the value of their services is conceded. In order to meet the exigencies of the department, the withdrawal of these details has become imperative. Engineer-in-Chief Melville regrets the necessity, as, in a measure, defeating the intention of Congress to aid the cause of education, and he urges such an increase of the force as will render it needless. Certainly this state of things is not creditable to the Navy, but whether, with an approaching presidential election, causing political considerations to overpower every other, in the motives of the average legislator, any immediate relief is to be hoped for, may well be doubted.

A Contribution to Aeronautics, being a chart showing area, velocity and horse-power required to sustain one pound in horizontal flight by the use of a square aeroplane, the units being square feet, miles per hour, and English horse-powers, has been prepared and copyrighted by Mr. Charles W. Hastings, 205 La Salle Street, Chicago, the price of the chart in the form of a blue print together with the accompanying explanations being 0.75 cents. Strict accuracy is not claimed for this chart, but it is nevertheless a good piece of work, and is thought to be as nearly accurate as present knowledge of the physics of moving fluids will permit; sufficiently so to enable any one interested in the problem of artificial flight, to obtain a fair approximation of the data which the chart purports to give. The graphic representation is reached by the use of ordinates representing areas, and abcissas representing velocities, through the intersections of which curves are traced, these curves representing the horse-power required. The calculations are based first, on two empirical formulæ, one expressing the force of wind against a plane at right angles to the direction of the wind and the other the force of wind against a plane inclined to the direction, this last being the formula of Col. Duchemin of the French army—secondly, upon a rational formula expressing the horse-power needed for sustentation, which is thought by Mr. Hastings to be original with him. This formula, together with a demonstration of it, is included in the explanations accompanying the chart.

The Canmell Solid Steel Armor Plate is a new English production, the composition of which has not been made public, and, if the plate be adopted by the English government, may remain a secret at least for some time. A test of a plate 10½ inches in thickness and weighing 10 tons was recently made at Portsmouth, which, according to the reported results, shows the metal to possess remarkable resisting power. It was attacked with 5 successive projectiles each weighing 100 lbs., and projected against it at a distance of 10 yards, by a charge of 48 lbs. of powder, 2 Palliser chilled shots and 3 Holtzer armor-piercing shells being used. The Palliser shells did not injure the plate. Of the Holtzer shells 2 rebounded; the other penetrated the plate sufficiently to remain in it, but no cracking of the plate resulted.

The Accident to the *Wetmore*, in her passage around Cape Horn, is nothing more than might have happened to any ship under similar circumstances, and will not have the effect to retard the construction of whalebacks, as appears to have been anticipated in some quarters. It now appears that she outrode a gale lasting five days and of a severity that would have tested the sea-going qualities of any vessel afloat. The statement that the vessel had been libelled heavily by the owners of the *Zambesi*, which towed her in, is now denied. That the *Wetmore* was considerably damaged there is no doubt, but there are few ships that could be knocked about five days, as she was, without having something to show for the encounter.

The Manufacture of Steel Railway-ties, it is said, is to be commenced by a company recently organized in Chicago with a capital of $1,000,000. Some advantages other than mere durability are claimed for steel ties as compared with wood, among which are a reduction of oscillation and vibration and less wear and tear of rolling stock. Any sudden revolution from wood to steel ties is not to be expected.

# ARCHITECTURE.

THE Positions of Radiators for steam-heating or hot-water heating, is, if one may judge from most building plans, rarely considered by architects. Except that the radiators or registers must go in *somewhere*, very little thought is given to this point, yet it is essential to a good heating apparatus that the radiators or registers should occupy advantageous positions. A room always has one side (corner rooms have two) colder than the others, exception being of course made for dark inside rooms, and the reason for this side being colder, is that it has an outside exposure. If the radiator, or the register be placed near the side of the room opposite the cold side, any one sitting near the cold side will experience the sensation of cold drafts. The reasons for this are two. The warmed air rising from the radiator or register flows upward over the nearest side wall, spreads in a stratum over the ceiling, finally reaching the cold side where it is chilled and begins to descend, thus forming a draft of colder air within the room itself, and wholly independent of any air flowing in through crevices in windows or doors. To the cold wall, also, heat radiates rapidly from the body of the person sitting near it, while from the warmer wall and the radiator situated near it heat radiates to him, and hence, while one side is receiving heat the other is losing it. Even without any draft this alone would produce the same sensation as a draft, cooling one side of the body, and rendering the surface temperatures unequal. One may plunge both hands into water at 70° F. and say it does not feel cold; he may also plunge both hands in water at 100° F. and will say it is only warm; but let him put one hand in water at 70° and the other in water at 100°, and he will at once pronounce the one cold and the other hot. Let one side of the body be exposed to a temperature of 70° F. and the other to a temperature of 60° F., and there are few that would not soon complain of discomfort; and the effect upon the nervous system in general would be the same as a cold draft, often inducing sneezing and the premonitory symptoms of a cold. The danger would be far less were both sides uniformly exposed to the lower temperature of 60° F. This evil is intensified in modern buildings through the profuse use of glass, which not only makes the exterior wall colder than it would be were less glass employed, but the glass is often so arranged also, that it is impossible to place any heating appliance near it. Most likely a large bay window brought clear down to the floor, occupies almost the entire end of a corner room, while the sofas, piano and other furniture which the room has been specially designed to receive force the radiator or register back to perhaps the most remote position from the glass it could possibly occupy, thus leaving that part of the room that needs most heat to get the least.

A Point in the Adaptation of the Walls of Buildings in Cities to modern requirements, will be new to many readers. This was brought out in the address of Prof. Emile Trélat before Section VI., in the seventh International Congress of Hygiene and Demography, recently held in London. He said that "all large towns follow an organic law of civilization which tends to make their populations more and more dense, *i. e.*, to limit the available free space within limits constantly narrowing. There is a consequent tendency to make walls less and less thick. Health considerations lead men to defend themselves by walls against the rain, the wind and storm, but there is another consideration which is not too obvious. Every inhabited house should be regarded as a workshop, which we were all trying to render unhealthy. The *rôle*

therefore, of the wall is double. It should (1) guarantee the interior space from the variations of the outer atmosphere, and (2) it should resist the infectious tendency which necessarily accompanies the action of the vital functions of the occupiers. The protection required is threefold—mechanical, hygrometric and thermic." The discussion of means and materials for making walls that meet these requirements is too long for such space as can be here afforded; but the speaker's remarks upon thermic perturbations merit wide attention. He gives as the reason that people complain so much in winter, the fact that the walls of buildings are so constructed as to permit a too free passage of heat from one side to the other. He said that sixty years ago "we clothed ourselves more warmly and built our houses with thicker walls. At the present day we are continually reducing the thickness of the linings of our coats and the thickness of our walls." The latter should be so thick as never to allow injurious changes of interior temperature, no matter what may the changes outside.

The Monier's System of Construction, several times spoken of in former numbers of this magazine, is extending rapidly abroad. *Industries* (London) adds to other advantages hitherto claimed for the system that the materials used are fire-proof, and cheaper than any others at present employed, and that the thinness of the material permits a notable economy of space. Our contemporary gives a great number of illustrations of various uses to which the system may be successfully applied. Among these are sewers; water pipes; electric light conduits; a bridge, with a span of 125ft. and only 7½ in. thick at the crown, constructed at Bremen; a loading test carried out on a bridge built on the Monier system at the Imperial Austrian Southern Railway Company's goods yard near Vienna; a series of silos constructed for the Roumanian Government at the harbors of Braila and Galatz; a glass works, the floors, ceilings, walls, stairs, etc., of which were constructed on this system; a loading test made by the Hungarian Government on a Monier arch between iron girders—the width of span of which was 8ft.; thickness, 2 in.; and load, 31 tons—without deforming the arch; a view of a bridge constructed at Wildegg, Switzerland, which has a span of 120ft., the thickness at the crown being 8in., and a test of a bridge 30ft. span, by 12 ft. wide, and 6in. thick at the crown, made in the presence of a company of experts, and consisting first of a heavy moving load, and afterwards of a dead load of 196 tons, the whole of which was successfully supported.

The High-Building Mania still continues to be the mark for pointed criticism. One of the best of these has recently appeared in the *Northwestern Architect*, published in Chicago, where the mania first broke out in epidemic form, and which, by the way, is one of the best architectural publications that reaches us. In speaking of the rights of owners, the writer of the article cited proposes a simple way of giving both the owner and the public at large each their rights. "The individual owner seeks rentable space, the public wish light and air; it follows, then, that up to a certain limit of height the individual owner manifestly should be free to regulate his rentable space as he chooses, but beyond this limit a sense of public welfare should control him either with or without his consent. What more simple solution can there be than this—that the individual be allowed to continue the further erection of his building above the prescribed limit, provided that, in so continuing the area of his building as it emerges from the limit shall occupy not more than, say, 50 per cent. of the area of his land? Let him so continue until he has reached, say, twice the height of the original limit. If the area of his land is sufficient that he may profitably continue, let him be allowed to do so, provided, however, that in so doing he occupy, not to exceed, say, 25 per cent. of the area of his ground; and so on indefinitely, restricting the area as he progresses upward." This humorous sally is followed up by some further sharp satire. "We well know, after a moment's reflection," that "the average American citizen, desiring, as usual, to be right up in the front row, would translate this to mean a

thirty-story building on the street line with a great big hole behind. We would, therefore, have to teach him the manners he does not possess, and would gently inform him that after the first limit is passed, the 50 per cent. restriction will apply not only to area, but to frontage. He will scowl at this condition, but if there is 'money in it' he will accept it just the same. When the second limit is reached, we will push him back unceremoniously from the street line to the middle of his ground, and if he can see a dollar in it he will accept this condition also." These are samples of some of the feeling shown against the high-building craze in authoritative architectural publications, and are indications of a storm of protest soon to come, if these aggressive structures continue to offend good taste, and affront the public by their erection.

What is a Bay Window? Singularly enough this question, apparently simple to answer, has required the answer of experts in a recent litigation. The answer, as formulated by eminent architects and printed in the *Inland Architect*, is as follows: "Bay window, an adjunct of any shape that is designed to be an enlargement to a room, and which projects beyond the exterior face of a main wall of a building, and does not extend above the main cornice. It may have its foundation in the ground or be supported on corbels or otherwise." Upon this definition the *Builders Gazette* remarks, that it was probably made with special reference to the case referred to and that while it is a "fair definition of *bay*, though not in the generally accepted architectural signification of that term, it is equally applicable to niche or alcove, and does not define *bay window* at all." The *Builders Gazette* thinks the work "*glazed*' should be used to qualify "adjunct" and that the adjective "main" before cornice ought to be eliminated, as it is confusing when "applied to a building with a broken ground plan." It then tries its own hand at a definition: "*Bay Window*, an adjunct to a building that is designed to be an enlargement to a room, which is of any shape, which is glazed on a curve or on two or more sides continuously, which projects beyond the wall to which it is attached, and which does not extend above the cornice or coping of that wall. It may have its foundation in the ground, or be supported on corbels or otherwise." Most of our architectural readers will recall that ornament to the profession, the immortal Pecksniff, who, when somewhat overcome by drink on the occasion of the party at Mrs. Todgers' house, urgently requested that amiable lady to give him her idea of a wooden leg. Let us fancy now the shade of Pecksniff returned to earth and requesting the gentlemen of the entire profession to give him their idea of a bay window.

Apropos of Mr. Robinson's article in this number entitled "What an Architect Does for His Money," is an editorial in the *Building News* that, in discussing "Architects' Difficulties," divides the public into two classes,—"those who are ignorant of architecture, and those who know a little." The latter class is the one most difficult to deal with. While the client who knows that he knows nothing about architecture is generally content to rely upon his architect's taste and judgment, the one who knows a little is very apt to think he knows a great deal. At the same time, whatever ideas he has he is generally unable to express in an intelligible way to his architect at the outset, and so he begins and keeps up an annoying and intrusive interference during the entire progress of any work his architect has undertaken to plan and supervise. This gist of the editorial re-referred to contains a lesson which the lay reader contemplating building operations will do well to ponder; and a careful perusal of Mr. Robinson's article will also act as a wholesome corrective to any tendency he might otherwise have to question the value of his architect's services, or bother him with needless or impertinent interference.

An Example of Ventilation, as it may be met with in numerous public school buildings, is described in the *Northwestern Architect*. In this building a heating and ventilating apparatus was placed, that was claimed to be "adequate to the needs of an intelligent public." After two years' use, a test examination developed the fact that in the best ventilated room in the

building each occupant received only six cubic feet of air per minute, while in another apartment only three and two-tenths cubic feet were supplied to each pupil. In this case, the air supplied was good in quality though its quantity was miserably inadequate. This examination led to investigation of other schools in the same city, wherein the quantity of air inducted was not only found notably deficient, but was also found to be contaminated from impure sources. To remedy the evils, the overhauling, instead of being intrusted to an expert in ventilation, or to a competent architect (both ought to have been consulted), was intrusted to a *civil engineer*, whom our contemporary intimates was not specially qualified for the task, although "a well-meaning gentleman." How many parallel cases to this might be cited, only those experienced in the erection of ventilating apparatus are competent to estimate; but it is certain they are neither few nor far away.

A New Building Material produced at an establishment in Silesia, is described in *Dingler's Polytechnische Journal*, which states that it is as light as wood, and equally impervious to heat, while possessing the strength of building stone. It is also said to be as resistant as stone to atmospheric influences. This material consists of solid slabs of magnesite strengthened by wire cloth in the body of the slabs. Tests made with the material are said to have demonstrated that they can be drilled with ordinary bits, which does not seem compatible with another statement to the effect that they have a hardness between topaz and corundum. The slabs are stated to be adapted for interior walls of buildings, as a substitute for plaster walls, an advantage claimed for this use being that buildings with the magnesite walls are ready for occupation as soon as finished, the walls being perfectly dry. Attachment of the slabs is made by screws through drilled holes. That the material has merit, seems indicated by a statement that the Berlin railroad has used it very extensively for signal and guard-houses, having found it cheaper than corrugated iron. Paint is said to adhere well to the slabs, and therefore they are subject to the decorators' art in the same manner as wood. The material is also said to take a high polish.

The Value of Mistakes as exemplified in the profession of architecture was a point made in a recent lecture before the class in architecture of the Brooklyn Institute, by Mr. Walter Dickson, whose experience as an architect has not been small. Mr. Dickson said: "Perhaps we should conceal the fact that architects make mistakes; but they do, and the majority of their mistakes are caused by a lack of practical knowledge. Mark it in your memory, that to the profession at large, and to you as well, mistakes, oftener than otherwise, make the wiser and more careful practitioner. I do not by any means, recommend carelessness, but, depend upon it, that man does not live, who has ever amounted to anything, who has never made a mistake—unless it has been some terrible and inexcusable one—but that the experience derived from that mistake was of incalculable benefit to the world as well as himself."

Onyx is coming more and more into use in fine architectural work. None of the colored marbles can vie with it in effect, and, in consequence, the higher price of onyx does not much retard its adoption for high-class work. In order to preserve the material and quarry it with the least possible loss, blasting is avoided, and the blocks are got out with wedges and saws. The *National Builder* says that a blast might spoil thousands of dollars' worth, and to exemplify this statement tells a story of a man who owned an oynx cave, and after getting out some carloads by sawing and wedging, conceived the happy thought of drilling around and blasting out the whole cave. Expecting by this scheme to save a large amount of time and money he realized the saving in time, but spoiled some $50,000 worth of the material, none of which was fit for use except in mosaics. Our contemporary states that in the purchase of onyx blocks there is a considerable element of speculation, as its interior is liable to faults undiscoverable before sawing up.

# ELECTRICITY.

LONG Lines and High Speeds for Electric Railways are projected, and if current report may be accepted, some of these projects will soon be carried out either to success or failure. An electric railway from Buda Pesth to Vienna is one of these schemes, and the German papers express the belief that it will soon be realized. The enormous speed of 125 miles an hour is spoken of as anticipated for this line. Instead of trains, single cars forty metres in length with pointed ends to diminish the resistance of the atmosphere, and with a powerful electric motor at each end are to be used; and, in these, it is expected the distance between the two cities, 150 miles, will be traversed in 75 minutes, the cars running at 15 minutes headway. There is no doubt that cars of this construction running on a perfectly straight track of thoroughly bedded, heavy steel rails, could make very much faster time than has yet been attained on passenger railways; but 125 miles per hour—may the writer live to see it!

An Electric Railway of sufficient length to demonstrate, once for all, the feasibility of this kind of propulsion for long lines, is projected; it is said a company has been incorporated in Springfield, Ill., to carry out the project. Among the promoters and organizers of this company are named, Gov. Francis, Congressman S. W. Cobb, John W. Harrison, I. G. W. Steadman, Web M. Samuel, E. S. Rowee, William H. Thompson, President of the Bank of Commerce; Dr. Wellington Adams, the inventor of the first successful electric motor, and John P. Kaiser, gentlemen of commercial and financial influence, themselves representing a large capital. The projected line is from St. Louis, Mo., to Chicago. There are many interesting features in the scheme. In the first place, the distance is 250 miles in a straight line between the two cities, and the road is to be built entirely without curves. The company expects to run cars at a rate of 100 miles per hour,—a speed, that notwithstanding contradictory opinions, is sure to be reached in the near future. The road will have a double track. The power will be generated at Clinton, Ill., the fuel being there procured from a mine owned by the company. The plant at that point will not only comprise the power station for the road, but will have all the most approved electrical mining machinery for getting coal. It will be seen that the speed proposed, will bring the middle point between the two cities within an hour and a quarter from each of them, so that the entire length of the road will assume a suburban character, and real estate along the line may be expected to come into market for building lots, upon which residences will soon spring up after the road is opened. The project includes a scheme for supplying electric light to buildings all along the line, and also electric heating. Trains are to carry electric headlights and tail-lights, that, at night will illuminate the track (which is to be double) for a mile to the front and a mile to the rear of the trains; and an electrical block-signal system is to be employed over the entire length of the line. This a most comprehensive and important scheme, and, as it is authoritatively announced that the preliminary work is nearly all finished, and that the contract will soon be let, the enterprise seems to be on a solid basis. It is to be hoped that the road may be completed before the opening of the World's Fair, and the projectors announce their intention to have it in working order before that event.

Electricity is to Be Applied to Flour Milling, it is stated. This new application is to be carried out in St. Paul, Minn., in a large flour mill built expressly for the purpose, the machinery of which is to be

driven by electro-motive power derived from the falls of St. Anthony. The projector of this mill, Mr. Kingsland Smith, according to report has been experimenting on this application of electro-motive power for a considerable time, and with such encouraging results as have led to this practical conclusion.

A Suit of Some Importance has recently been tried at Salem, Mass., between insurance companies and electrical companies, the suit having grown out of the bursting of a fly wheel in an electric lighting station at Lynn, Mass. The accident partly wrecked the station and seriously injured adjoining buildings. Besides the damage due to the projectile force of the fragments of the wheel, a damage of a little more than one thousand dollars resulted from fire. Some twenty-three different fire insurance companies were the defendants, the Lynn Gas and Electric Light Company, on whose premises the accident occurred, being the plaintiff, suing for the payment of the entire damage sustained, on the ground that the bursting of the wheel was incident to a fire caused by short circuiting of wires in the tower of the station, that this disturbed the action of the dynamos so that they broke their pulleys on the main shaft, breaking the pulleys and causing a broken piece to be driven under the fly wheel in a manner that caused the latter to break also. The insurance companies opposed this claim by the contention that the engine ran away through the breaking of the governor belt, or from some other defect in the belt, as unlacing or stretching, that, the engine, just before the breaking of the fly wheel, it was running at a speed so much above what was normal, as to cause the regulators of the dynamos to fail in controlling the current, and that the fire caused by short circuiting was thus not the cause of the succession of events culminating in the damage done, but that the undue speeding up of the engine was the primary source of all the mischief. Several eminent experts were called to support the contention. The suit was tried before a jury who gave a verdict to the plaintiff, the view being taken by them that the fire was the cause of all the damage, and that the small amount of damage directly done by fire, and which the insurance companies had offered to pay to the plaintiff, was not the extent of their liability.

The American Institute of Electrical Engineers, in its printed transactions of regular meetings respectively held Nov. 24, and Dec. 16, 1891, has also printed a brief history of the origin and growth of the association. The first meeting looking toward the organization was held on the 15th April, 1884. The call was signed by prominent gentlemen and was issued in view of the fact that an International Electrical Exhibition was soon to be held in Philadelphia, and that, as stated in the call, "it would be a lasting disgrace to American electricians if there were no American National Electrical Society" to receive the eminent "foreign electrical savants, engineers and manufacturers," expected on that occasion. On May 13, of the same year "a permament organization was effected," Dr. Norvin Green being the president, and the most prominent electricians of the country filling other official positions. An act of Congress approved July 7, 1884, authorizing the President of the United States "to appoint a scientific commission which might, in the name of the Government, conduct a National Conference of electricians in Philadelphia, in the autumn of 1884, provided that the commission appointed might invite scientific men, native and foreign, to participate in the Conference and to determine the general character and scope of its work," and the conference held in accordance with the act in the rooms of the International Exhibition Building in September of that year, was a notable event in the history of the association, which then took and has since held its place among the most honorable and useful of scientific bodies. Its original practice of holding annual meetings has been changed to regular monthly meetings, the transactions of which show that its members are doing excellent work. The proposed International Congress to be held in Chicago in 1893, being an adjourned meeting of the Frankfort Congress held last year, and, in which the American Institute of Electrical Engineers will partici-

pate, will doubtless prove one of the most interesting scientific events of the present decade. At its regular December meeting the Electrical Congress Committee presented the following resolution, which was approved at a special meeting of the Council held on the 23d of the month.

"*Resolved*, That the American Institute of Electrical Engineers, having already taken action during the past three years, by correspondence and otherwise, towards the holding of an International Electrical Congress in connection with the Columbian World's Fair, hereby expresses its desire and intention to co-operate, by all means in its power, with the World's Congress Auxiliary of the World's Columbian Exposition, through its Electrical Congress Committee, in furthering the gathering of such a Congress at Chicago in 1893, and in making it a successful and worthy representation of the best electrical science and practice in all parts of the world."

The Cockroach Plague, in London Clubhouses is paralleled by what is happening in Orizaba, Mexico, said to be suffering from a plague of insects attracted by the electric lights in that city. The New York *Evening Post*, says of this plague, that the "bright light of the lamps attracted millions of winged insects from the mountains, who swarmed about the lights. Every morning found great heaps of them dead about the base of the lamp-posts. When the hot sun began to broil this mass, the stench that pervaded the city was terrible, and fever broke out among the inhabitants. Wagons are necessary to remove the heaps, and the operation has to be repeated every morning before daybreak." This statement without rather close scrutiny might leave it doubtful whether it is the insects or the mountains "*who*" (sic) are doing the swarming; but a comparison of the respective well-known habits of insects and mountains, and the heaps of insects about the lamp-posts set the reader right. The fact narrated brings to mind an idea for the construction of a deadly insect trap which has recently occurred to the writer. Nearly all nocturnal insects will fly toward a powerful light. Let such a light be surrounded by a large net or a coil of electric wire through which the insects will endeavor to reach the light, and so arranged that when they fly against it they cannot avoid short circuiting the current through their bodies. This system of electrocution, or, more preferably, "*calelectrization*," (vide page 848 last volume of this magazine) applied in vineyards, peach orchards, etc., might be effective, and so far as the writer is aware it is entirely new.

There is "Nothing New Under the Sun," however, according to Solomon the Wise, and it would seem that this is exemplified in electrical inventions and patents as forcibly as in any other class of human affairs. The *Electrical Review* (London), has recently printed an account of a patent granted by the Italian Government June 20, 1866, to Felice Marco, of Florence, the specification for which patent describes, in general terms, the principles of the use of water-power for electric lighting. In it the inventor says: If this machine (*magneto-electric Machine*, he calls it), "is placed in a locality where the gratuitous mechanical force of water can be utilized, electricity is produced without cost by means of said machine. It can be conveyed by means of metal wires to points where it is needed for producing the electric light, and for operating electro-magnetic machines; these machines have up to the present time not been used solely on account of the expense of the acids and metals required to produce the electric current, which far exceeds the cost of fuel used in steam engines. The application which I propose is, to produce the electric light gratuitously, and to permit the transportation of the mechanical force of waterfalls and streams of mountains and plains into a city by means of the magneto-electric machine. This is undoubtedly the most simple and rational solution of the problem of the production of electricity and of its application for the production of light, heat and force." It is quite evident that Felice Marco (one is tempted to ask after the manner of the Doctor in "Innocents Abroad," *Is he dead?*) was one of those unfortunate individuals who have ideas—sometimes, very original, good ideas—in advance of their times. Formerly the world used to stone such people to death, break them in two on the rack,

or burn them. At the present time we treat them much more humanely; we simply call them *cranks*, and let them die in poverty and neglect.

The Trolley is to be used in Brooklyn, notwithstanding the strong opposition that has been made against it by the press, the mayor and a large number of influential citizens. Mayor Boody whose veto was overridden by subsequent action of the common council, has allowed the time to elapse that legalizes the action of aldermen without his signature, and this, to all appearance, ends the struggle. As to the merits of the controversy as regards danger, time will supply arguments, on one side or the other. As to the unsightliness of trolley wires and poles, there can be no honest difference of opinion; but in the language of the wise Mrs. Partington in one of her lectures to "Ikey," "looks aint everything." The advantages of quicker transit and cleaner streets, may go far to remove objections based merely on esthetic grounds; and possibly may compensate for every other disadvantage. As to the *deadly trolley*—a pet phrase of objectors, that has done good service in prejudicing the public mind—it must be remembered, that people are killed or maimed even on our ordinary horse-car lines. The writer once saw a man run over and killed by a horse-car in New York City. Attempting to cross before the car in slippery weather he fell in front of the car and although the driver did his best and promptly attempted to stop, he failed to do so in time. Now had this man been killed by a trolley wire, it would have made a sensation in all the daily papers, calling forth columns of comment and denunciation; as it was, beyond a brief mention, very little was said about it. The tendency seems to have been to magnify the danger assumed to inhere in the use of the trolley system, and stubbornly to ignore the fact that danger exists more or less in any system of propulsion. The proper way to consider this question, is to compare the number of accidents with the extent of traffic. That system in which the number of accidents is greatest in proportion to the number conveyed is the most dangerous. So considered, common carriage riding, about which no one ever thinks of raising a protest, would probably turn out to be far more dangerous than any system of railroading, be it steam, pneumatic, or electric, either with trolleys or underground conductors.

A Submarine Cable will be laid between the Bahama Islands and a point on the south-east coast of Florida. This will connect these islands with the telegraphic systems of the world from which they have been shut out hitherto. The cable has been designed for the government of the English Colony by Mr. W. H. Preece, F. R. S., one of the most widely celebrated and accomplished of living English electricians. The insulation will be gutta percha. The work is expected to be completed on or before the close of the present month. The terminus on the Florida coast will be at Jupiter Inlet, and, for the present, messages will be transmitted from this point, to reach the Western Union Telegraph system, by the officers of the U. S. Weather Bureau; thence communication with Europe will be through Atlantic cables.

The Oxyhydrogen Light must soon give place to the electric arc light, which is much superior in intensity but generally has been considered as too unsteady for lecture lanterns. Improvements in regulation have so far removed this objection, that the arc light is now used successfully in place of the oxyhydrogen light, and as greater perfection is gradually attained this application is sure to be extended. The *Progressive Age* says that Prof. D. L. H. Laudy of Columbia College has adopted the arrangement of carbons, introduced some years ago in the Foreland lighthouse, by which the crater in the carbons is made to maintain a constant relation with the focal axis of the lens. This arrangement together with a uniform feed and a uniform voltage prevents hissing and flickering. The journal cited states that the ordinary oxyhydrogen lantern can be altered cheaply and easily to adapt it to the electric light, and that the electric light is much more easily adjusted to produce the desired illumination of lantern slides than the oxyhydrogen light, while the cost is only about 20 cents per hour.

# MINING AND METALLURGY.

CORDWOOD in the Matting Blast-Furnace is said by Mr. Herbert Lang in a paper read before a recent meeting of the American Institute of Mining Engineers, to be a regular constituent of the fuel charge at Mineral Idaho. He says: "The furnace is a round jacket furnace 36 inches diameter at the tuyeres, the melting mixture being 950 lbs." In melting, he uses 55 lbs. of coke and 135 lbs. of firwood, cut from dead dry trees, this fuel being equivalent to 110 lbs. of coke. From the results, Mr. Lang estimates that the ratio of smelting effect of wood to coke weight for weight is 11 to 27, while the cost of the wood is less than half that of Connellsville coke delivered at the mine. This advantage in cost is, however, the least advantage in the use of wood, as Mr. Lang finds wood far more efficient in burning out sulphur than coke, "thus allowing the use of a larger quantity of sulphide ores in the charge," which, he adds, is "a point of great moment" at Mineral, where this kind of ore predominates, and where there are, as yet, no roasting furnaces. Disadvantages in the use of wood are the production of more flue dust, and the reduction of "smelting capacity," which latter Mr. Lang estimates to be about one third, "but the furnace keeps in good condition above and below, the tuyeres remain unaffected, the slag is hot and reasonably free from valuable metals, and the conditions of successful smelting are met in all respects, except as to the serious reduction of tonnage." That the wood is not converted into charcoal in the furnace before it gives any effect in smelting, and that the volatile constituents of the wood are useful before their escape from the furnace, Mr. Lang shows from the fact that 135 lbs. of wood will produce only 27 lbs. of charcoal, an amount that is clearly much below the equivalent of the coke that the wood replaces efficiently. Moreover, there is no evidence of free sulphurous acid in the smoke, and he believes that the sulphur forms with the volatile constituents of the wood some sort of volatile compound, the formation of which is attended with a considerable evolution of heat.

A New Discovery in Iron Making is quoted by the New York *Sun* from *Iron*, which latter refers the statement to the *Dusseldorf Zeitung* as its authority. The German paper, having previously intimated that a very wonderful new discovery in iron making had been made which statement was generally held to be ridiculously incredible, repeats the statement with the comment that "in due time all doubts will be dispelled." This statement is, in substance, that not only iron, but also other metals, such as gold, silver, copper, and aluminum, can be extracted from their ores by the new and infinitely cheaper method. When it is considered, it continues, "that the current generated by a dynamo driven by a small gas or petroleum engine will be capable of extracting day for day more metal than the largest blast furnace is able to produce, some idea may be formed of the radical changes which are likely to be the result of the employment of the new process." The invention, which is more rightly described as an electro-technical discovery, was perfected three months ago. The inventor has succeeded in devising a practical process which has secured the ready support of a number of well-known American and German capitalists, who purpose forming a gigantic international syndicate. The assertion is made, further, that 80 per cent. of the cost of the present cost of blast-furnace methods will be saved by the use of the new discovery. It is hard to see how capital can be attracted by the small percentage of saving claimed; if it had only been 100% or 125% there would be some encouragement for investors. That such a claim would prove credible to some people is evident from the fact that in a neighboring city there is

said to be some capitalists who are backing with money an inventor who claims to be able to produce, with a mechanical pump, a vacuum of 35 inches barometrical column. These things remind one of the Keely motor craze, and the claims for the iron process are convincing that the fools have not yet all emigrated from Germany.

Rock-Blasting by Electricity is the subject of a notable series of papers of special value to practical men, now running through *Stone*, the excellent quarrying journal published in Indianapolis, Ind. The author is Mr. William L. Saunders, whose varied experience has covered every phase of practical work, and in these papers he aims to show the best methods now in use for blasting rock, calling attention and laying special stress upon the weakness that exist in the methods, notably in the batteries and detonators. Many accidents have occurred, some of them having recently attracted attention in New York in which lives have been lost through premature blasts, and Mr. Saunders has traced the disastrous "missed hole" to too small an exploder which produced so weak a detonation that the entire cartridge did not go off, and again, to so weak a current from the battery that where several hollows are connected in series, some of them will go off and others will miss. He advises a fulminating cap of large size or several caps together so as to produce a stronger initial detonation, and a battery that not only throws a strong current in the line, but which is less dependent upon the personal equation of the operator.

The Explosion in the Osage Mine, noticed in our last number was discussed at a recent meeting of the Engineers' Club of St. Louis, and in the course of the discussion one of the members gave an account of the disaster. From the statement of this gentleman the mine appears to have been "well equipped, having duplicate pumps, steam and electric, duplicate fans situated at considerable distance from hoisting shaft; an electric plant for pumping and lighting, with the engines and boilers, is housed in substantial stone buildings. Two separate openings or escapement shafts besides the air shaft are provided, and are in daily use. The main shaft is 475 feet deep. The explosion was started at 5.04 p. m., by a blown out or 'windy' shot or blast fired contrary to rules before the miners had been hoisted out of the mine. Gas or fire-damp was not a factor in the explosion, and powder played no part except as fired in the fatal shots in blasting down the coal. Coal dust seems the only remaining medium capable of carrying the explosion over the two thousand feet or more of entries which were affected by the accident." This statement emphasizes the remarks made upon the causes of explosions in coal mines in the notice above referred to. Here was a condition of danger in the coal dust pervading the mine, and a violation of rule occurring simultaneously with the dangerous state of the mine. The concurrence of these resulted in the disaster. Will not the managers of mines see from this accident the necessity for discipline almost military in the severity of its enforcement, since the natural conditions of danger may sometimes exist unsuspected?

Discrepancies in the Behavior of Steel are spoken of by Mr. John Parry in a rather abstruse article contributed to *Nature* on "The Spectrum of Iron and The Periodic Law." Much of this article deals with the subject of spectrum analysis, and it contains a valuable account of many important researches, as well as some practical conclusions of immediate value to steel-workers. As an instance of some anomalies encountered in the behavior of steel, he cites an example wherein "steel containing traces of silicon, .12 per cent. carbon, .06 of sulphur, .07 phosphorus, .40 per cent. manganese, stood a tensile strain of 27 to 30 tons per square inch; other samples of the same composition showed an increase of 31 to 35 per square inch, and under these latter conditions the carbon had to be reduced .12 per cent. to stand the normal test of 27 to 30 tensile strength." From various considerations he concludes that "steel must be worked at a certain fixed, but as yet unknown, temperature below the fusion point, at which heat the flow of heated metal undergoing compression and elongation is

such as to insure good practical results." Can this temperature be discovered? Probably, if Mr. Parry's conclusions are accepted, scientific investigation will be directed to the determination of this critical point.

Analysis of Tin Ores, in these days of search for tin deposits in the United States, is a live subject. Dr. J. S. C. Wells has contributed to *Iron* an easy method for obtaining tin from its ores which he regards as a satisfactory substitute for previous tedious and unsatisfactory methods. He uses nascent hydrogen, having conceived the process from the action of this gas upon artificial oxide. About one gramme of finely pulverized ore is placed in a test tube, with some granulated zinc and hydrochloric acid by which the tin is reduced through the action of hydrogen generated by the reaction of the acid upon the zinc. This process, being effected in about an hour with Cornwall ore, did not act so rapidly upon nearly pure cassiterite (Durango ore); but when a piece of platinum was introduced the reaction was effected with the same rapidity and facility as with the Cornwall ore. The reaction is also found to be accelerated by boiling and shaking. Dr. Wells advises, further, that as soon as the decomposition of the ore appears to be complete, the remaining zinc and reduced tin should be filtered to separate any undecomposed ore, and that this should be again treated to determine whether all the tin has been extracted. The reduced tin and the remaining zinc are then reduced to chlorides by dissolving them in hydrochloric acid, when the separation of the zinc chloride may be effected according to usual methods.

Zinc In Australian Silver Ores, which has hitherto been a waste product, is now said to be recovered or, rather saved in the treatment of sulphide ores, and turned out in marketable shape. The *Australian Mining Standard* says that a report has reached it from the English and Australian Copper Company's smelting works at Port Adelaide, that the manager has solved this important problem. It does not describe the nature of the process, but it adds to the report the remark that if this be true it will mean a great deal to fields where zinc is present in embarrassing quantities in the ores. The demand for zinc is increasing at a faster rate than the supply of the metal, and the price has within the past two or three years made a rapid advance. Ore yielding as little as 12 per cent. of zinc is treated with profit in Germany, and as some of our Broken-Hill ores give as high as 25 per cent. of this metal, there ought to be illimitable possibilities before us as contributors to the zinc supplies of the world.

Coal Dust as a Cause of Explosions in Mines has been the subject of an investigation by a Royal Commission in England. The result of the examination of witnesses, as given in the final report of the Commission, makes it plain that a consensus of opinion exists on the part of mining experts that dust is a powerful factor in mine explosions. Not only is a large quantity of dry floating dust capable of generating an explosion, but in case of an explosion of fire-damp, it intensifies and renders disastrous what otherwise might prove comparatively harmless. As a means of meeting this danger, among those proposed, is systematic sprinkling, but, as yet, the Commission withhold their views upon its value. Sir Frederick Abel, one of the investigators, gives it as his opinion that a very small amount of fire-damp mixed with coal-dust is sufficient to establish the conditions of a violent and disastrous explosion, and he also thinks that coal-dust alone is sufficient for such a result.

The Rivalry of Japan with Australia in the Coal Trade is probably the beginning of many future commercial battles and possibly military conflicts yet to be recorded in history between these rapidly advancing seats of empire. The matter of the coal rivalry is discussed at length editorially in the *Australian Mining Standard*, which quotes an influential financier of Sydney, as declaring that he would no longer hold Australian coal shares at any price. It further asserts, that while the sellers of coal shares are many, the buyers are few, and avers that competition and cheap labor have shunted Australian coal into the back-ground. Japanese proprie-

tors can draw from a dense population a mass of cheap laborers, and can load coal at rates much below what is practicable in Australia with its complex and arbitrary labor organizations.

A New Alloy has been brought out in Germany, and the name *manganine* has been adopted for it. It is said to consist of copper, nickel and manganese, and the properties that principally distinguish it are its high-electrical resistance, and the slight variation in its resistance produced by heat. Its specific resistance is said to be 42 microhm centimeters, the highest specific resistance yet obtained in any metal or alloy. A curious fact relative to the slight variation of resistance which heating the alloy produces is, that the resistance decreases with increase of temperature, while, with other metals, resistance increases as the temperature rises. If these statements be confirmed, this metal will find use in the construction of a large class of electrical instruments wherein great uniformity of resistance is essential to accuracy and delicacy of measurement.

Platinum Vessels for Concentrating Acids are said to be undergoing experiment in Germany, under a recent patent, the new feature being the coating of the platinum with gold. The inventor claims that the vessels will last much longer when so coated. This claim yet wants practical confirmation, but the method of applying the gold is interesting as a metallurgic process. *Industries* (London) says that the sheet platinum for constructing the vessels "is coated with a layer of gold by heating it to a temperature higher than the melting point of gold, and then running the molten gold over it, in some suitable mold. This double sheet can then be rolled, and is then fit for the construction of small vessels which will serve as substitutes for the gold pan and covers required in chemical laboratories and other purposes."

Sapphires and Rubies in Montana were referred to in our February number in connection with the organization of an English company formed to work the deposit. Since this announcement was printed, the *Financial and Mining Record* states that another English corporation has been formed to work a concession for forty miles of gem-bearing land in Siam, around the Chantaboon and Krat mines, the concession being for twenty-five years, and the corporation having agreed to pay for it a royalty of twelve per cent. of the net profit on the gems, twenty per cent. of the profit on metals obtained, and a yearly rental of £5 per square mile. The beginning of active operations in the development of this important concession was in October last, since which period the company has received one shipment of sapphires and rubies, and telegrams announcing two other shipments, the three shipments aggregating the handsome total of 210,000 carats.

Coal of Fair Steaming Quality, it is said, has been discovered accidentally by the captain of an Italian ship, who anchored his vessel in the Straits of Magellan, and it is added that experts, sent to the straits to investigate the deposit, declare it to be abundant and easy to mine, as the seam lies near the surface. Such a deposit may be conceived of as a matter of some importance to sea vessels sailing around Cape Horn, supplying a coaling station by which a supply could be renewed, and consequently increasing their cargo capacity.

A Remarkable Diamond has been recently found on the Koffeyfontein Diamond Mining Company's ground in Australia, which appears to be of such value that even competent judges hesitate to name a price commensurate with its worth. It is said to be of a beautiful shade of pink, entirely devoid of spot or blemish, and to weigh 13½ carats. It appears that the diamond mine at Koffeyfontein is acquiring a reputation for specially beautiful gems.

Aluminum in Colorado is discussed in the *Mining and Scientific Review*, which describes an extensive deposit of clay near the foothills of the Rocky Mountains thought particularly adapted to the commercial production of this metal. It states also that preliminary experiments have been performed and that a corporation has been formed in Denver to manufacture the metal from the clay named.

# MECHANICS.

THE Electric Welding of Pipes in pipe fitting spoken of in the July number of our last volume, as a possibility, and for which, when accomplished in a practicable way, certain advantages were pointed out, is near its realization. According to *Engineering* (London) a Birmingham firm, has not only applied this method to the manufacture of wrought iron fittings, but also to repair work, doing work, asserted by our contemporary to be beyond the capacity of the most skilled smith. Some illustrations of fittings made in this way, accompanying a description of the manner in which the work is done, appear to justify the assertion. Manifolds, or branch-tees, oblique fittings, as ells with one inlet and six outlets, and reducing tees, are among the examples illustrated. These fittings, seemingly impossible to any ordinary process of forging, if produced in cast iron, would weigh at least twice as much as they now do. The possibility as well as practicability of electric welding to the erection of pipe jobs is confirmed by the following statement. The welding is done by concentrating upon a small area the heat generated by an electric arc. "It is well known that the temperature of the arc is the highest that can be produced artificially, exceeding that of any form of furnace. Hence it will be readily understood that not only will it raise a piece of iron to the welding point, but that it will also readily fuse it, and make it run just as if it were solder. It is not, however, feasible to form an arc of such dimensions as to embrace the whole of even a moderate sized forging. An area of two square inches is about as large as can be treated at once, without special appliances, and hence the making of a large weld by this system has to be done piecemeal. A portion of the two surfaces is first united, and then a second portion, and so on until the entire areas are welded together. Loss by wasting does not trouble the workman, because he can make it good by melting small pieces of iron or steel on the work, thus actually increasing its dimensions, if desired, as he proceeds." The arrangement for applying the arc is exceeding simple. The work is "connected to one pole of a dynamo either by a flexible lead or by lying on an iron bench, and with a carbon joined to the other pole and carried in a non-conducting handle the smith can apply the arc just as he sees fit, either concentrating it on a spot the size of a penny, or moving it backwards and forwards in a narrow line. In 12 seconds he can melt an inch hole through a $\frac{3}{8}$ in. boiler plate, and can then prolong this hole into a slot, cutting the plate into any shape he pleases. So intense is the heat that the operation can be conducted under water, and the iron fused while deeply immersed." The work is consolidated under the hammer, as soon as the arc is broken, and before it has time to cool. It is claimed that this welding is done at one-fourth the cost of welding by the gas flame, one source of economy being the fact that no electric current is wasted, the current ceasing instantly when the carbon is removed and acting only when it is wanted; whereas, gas burns when it is not wanted. For ordinary work the smiths' fire and the usual process is cheaper; but in positions where welding cannot be done in the usual way, and for work to which on account of its form, the ordinary process is inapplicable, electric welding is a valuable substitute.

The Manessmann Steel Tubes from the success which has attended their use abroad, and the numerous uses to which they are adapted, continue to attract the attention of American mechanics and manufacturers. There remains no doubt that in these tubes an important addition has been made to previously existing materials, and that further uses will be found for them is certain, as soon as they are rendered available in quantity to Ameri-

can manufacturers. The beautiful finish of these tubes commends them at once to the mechanical eye. In this respect they are above comparison superior to ordinary iron pipes. They are seamless, and are the only existing weldless and seamless tube having a spiral fibre. Their strength in proportion to their weight exceeds that of any known tubing. On page 687, Vol. I of this magazine, some statements with reference to the extraordinary lightness and strength of these tubes were made, and it was therein recorded that tubes 4¼ millimeters in thickness had withstood the enormous pressure of 2250 lbs. per square inch. What is needed to bring the merits of these tubes to the knowledge of American manufacturers is a proper and efficient commercial representation by some one capable of presenting them to the trade; as soon as this is done, it would seem that a wide and growing market must open for them. Some applications of the tubes suggest themselves. In the manufacture of bicycles they could be adopted with the result of getting greater strength with decreased weight. In pneumatic engineering, carried now to a point where enormous pressures must in many instances be sustained, they are superior to anything the writer has seen as a material for making connections, or for storing air under enormous pressure, such as is required for the projection of dynamite shells, etc. For boiler tubes, they seem to be specially adapted, and doubtless this adaptation is destined to create a large demand for them as soon as their qualities become generally known. The tubes being so thin, and possessing such a superior finish, may be found adapted to the manufacture of seamless kitchen boilers as soon as they can be supplied having the right diameter. The rapid introduction of these tubes into European industries is shown by the annual report of the Manessmann German-Austrian Tube Works, which states that £157,800 in value of the tubes have been made, netting a profit of £68,400. It is also stated that great progress has been made in perfecting the manufacture and in producing tubes of larger diameters. They are now made of sizes ranging from ¼-inch to three inches outside diameter, and of a thickness ranging from No. 23 to No. 10 Birmingham gage. Mr. D. B. McIlvain, of 111 Chambers Street, is in position to answer any inquiries about these tubes which may be addressed to him, and give full information with reference to them.

A New Cyclometer has been invented in England, by which variations in the velocity of rotation during a single revolution of an engine can be measured with great accuracy, and the part of the revolution in which the variation occurs can be located with precision. In its general features the instrument is extremely simple. A cylinder covered with smoked paper is connected by a simple device to the end of the engine shaft. On a slide rest that traverses in a line parallel with the axis of the rotating cylinder, is fixed a tuning-fork, kept in constant vibration by means of a small electro-magnet between its prongs. A small style is attached to one of the prongs in such manner as just to touch the smoked surface of the paper. The tuning fork being accurately tuned to a standard pitch the number of vibrations made by it a second is known in advance. The slide carrying the tuning fork being moved by a few screws slowly and steadily when the engine is at work, a wavy spiral line is traced on the smoked surface of the cylinder, and as the waves in the line are easily counted between any two points of the tracing, a variation in their number in any arc of the revolution from the number in any other arc, shows the variation in angular velocity for these parts of the circle, and so on for any other parts compared. In this way, any deficiency in the weight of a fly-wheel permitting too great a variation of speed during a single revolution may be at once detected.

"Machinery Pattern Making" is a book recently issued by Messrs. John Wiley & Sons of 53 East 10th Street, New York City, and written by Mr. P. S. Dingey, practical pattern-maker and mechanical draughtsman. The work is of an extremely practical character, illustrated by 376 engravings, the bulk of the matter having been originally prepared for the

*American Machinist.* The matter as prepared for this excellent weekly journal of practical mechanics has, however, been revised, and something added to the original series of articles. Those who saw something of the articles as they appeared in the *American Machinist* will scarcely need any recommendation of the book, the matter being its own recommendation. After some preliminary discussion of the general subject of pattern-making and the pattern shop with reference to its position, size and requirements, the general subject of pattern-making is taken up and illustrated by numerous examples, these being taken from forms of machinery most frequently used or illustrative of some peculiar point in the art. The work is well printed on good paper and bound in stiff covers.

A Remarkable Feat in the Erection of a Locomotive was recently performed at the shops of the Great Eastern Railway at Stratford, England. The engine is of the six-coupled type, and of a power sufficient to draw a gross load of 560 tons. *Engineering* (London) says the work of erection, which was accurately timed by its representative, was performed in 9 hours and 27 minutes, the time for different parts of the work, as condensed from its report, being as follows; The start was made at 9.8 A. M. Time, from the beginning of laying the frame plates in the usual way to driving of first rivet, 11 m.; foot plate casting fixed, 20 m.; motion plate in place, 26 m.; cylinders set and fixed, 1 h. 17 m.; setting of the motion completed, 3 h. 52 m. Here the men stopped for dinner. Work recommenced 4 h. 37 m. from the start. Engine wheeled, 5 h. 27 m.; setting valves commenced, 4 h. 15 m.; men quit for the day, 6 h. 27 m. from the start, or at 5.30 P. M. Work recommenced next day at 6 A. M. Valve setting completed 8 h. 22 m. from the start; side rods put on, 9 h. 2 m.; painting commenced at 7.15 A. M.; completed in 9.47 m. from the start, and locomotive run out of shop to be photographed. Meanwhile the tender had been completed, and later in the day the locomotive was run on its trial trip. Our contemporary says it has since been running regularly with coal trains. In the erection were employed 39 fitters, including 3 boys, 2 smiths and 44 boilermakers, rivet boys, etc.—85 in all. The excellence and accuracy of work, that could render this feat possible, must be almost perfection. There could not have been much wrestling with parts that would not go together.

A Cotton Mill in Denver, Col., having now 16,000 spindles, to be increased to 32,000 spindles, and another of the same size for which machinery is now going forward, indicate the growing tendency of manufacturing interests to extend in the West. The plans for these mills were furnished by a Providence firm. This marks the beginning of a western market for cotton machinery, that may, in time, develop into an important commerce.

Tests of the Relative Value of Lead, Sulphur and Portland cement for anchoring bolts in stone have been published in the Troy *Polytechnic*, which says that "fourteen holes were drilled in a ledge of limestone rock, all forty-two inches deep, and bolts, some three-quarters and others one inch, were set in the holes; around four of these bolts, sulphur was then poured, lead was put in around four more, and Portland cement, well mixed, around the others. Two weeks later the bolts were pulled by a powerful lever, and, out of those run with sulphur, one was drawn out under a strain of 12,000 lbs., with the others the iron yielding before the sulphur gave way; three of the bolts calked with lead also broke in place, one pulling out; but of those set in cement one yielded slightly and then broke, while all the others broke in place."

A New Protective Varnish for Metal Work exposed to weather is described in German technical publications. The process of manufacturing it is a rather curious one, being based upon the solubility of metallic lead at high temperatures in cotton-seed oil. For every 5 liters of oil 10 kilos of lead are melted and slowly poured into the oil with constant stirring, whereby 1.5 kilos of the lead are taken up. The cooled lead deposited at the bottom of the oil is then remelted and the process repeated till the oil is saturated, which occurs when 5 kilos of lead have been dissolved.

The oil is, by this operation, converted into a varnish which, applied by a brush in the ordinary manner, adheres strongly to metal surfaces. Two coats are required and the second should be applied not sooner than 48 hours after the first. The property of cotton-seed oil to dissolve lead, seems to distinguish it from other oils, although the oxides of lead dissolve quite freely, not only in linseed oil, but in walnut oil and other siccative oils.

A New Machine Gun is said to have been produced by Browning Bros. of Ogden, Utah, and to have been subjected to tests at the manufactory of the Winchester Arms Co. at New Haven, Conn. It is stated that its rapidity of firing is 900 shots per minute. These shots are fired from a single water-jacketed barrel, to which an endless belt supplies the cartridges. As the Maxim gun fires 750 shots per minute, it will be seen that the new gun, of which the mechanical details have not yet been made public, has reached, if the above announcement is exact, an increase of 32 per cent. in rapidity of firing over that famous arm; but as this may be gained at the expense of other essential qualities the question of superiority cannot be decided till the exact construction is known.

The New Catalogue of the Pelton Water Wheel Company is much more than a mere list of their wheels. Besides a complete description of these remarkable modern motors, a discussion of their principles, construction and proper methods of setting them, it has, between its covers, a great deal of matter that in a general way is valuable to hydraulic engineers. Much of this matter is tabulated for easy reference and the book is so well prepared, that once reaching the tables of engineers and draughtsmen, it will not soon be discarded.

A Source of Loss in Power in the Use of Chain Blocks, is pointed out in that excellent little trade publication *Hoisting*, issued by the Yale & Towne Company, at Stamford, Conn. This defect is found to arise from varying pitch both of the sheaves and the chain. This needs only to be mentioned, to be at once admitted by every practical mechanic. Unless both links and pockets accurately fit each other and quietly mesh, as do accurately shaped teeth in the best quality of gearing, there must be friction, chafing and wear, with the inevitable loss of power resulting. It is not enough that the pockets should have an accurate pitch; if the chain be at fault in this respect, it is just as bad. To work with minimum friction, each must not only have a uniform pitch, but the same pitch.

The Horse Power of a Whale, has been made a subject of study by the eminent anatomist Sir William Turner of the University of Edinburgh, Scotland, in conjunction with the equally eminent Glasgow ship builder, Mr. John Henderson. The size and dimensions of a great "*Finner*", stranded several years ago on the shore at Longriddy furnished the necessary data for a computation of the power necessary to propel it at a speed of 12 miles per hour. This whale measured 80 feet in length, 20 feet across at the flanges of the tail, and weighed 74 tons. To attain a speed of 12 miles per hour, it was calculated that 145 horse power was necessary.

Increased Viscosity of Lubricating Oils is said to have been attained by a German process, through the use of *suint* or wool grease. This substance having been converted into soap by an alkali, a solution of the soap is treated with a solution of alum. A brown precipitate results and is separated and dried for use. It is soluble in mineral oils and is claimed to impart to them any desired degree of viscosity according to the quantity added.

A New Water Pipe, consisting of an iron pipe lined with a block tin pipe forced into it by hydraulic pressure, has been placed on the market in England. The compound pipes are connected by tin-lined unions and are said to require no soldering or wiping of joints. They are also claimed to be perfectly amenable to bending and capable of standing any required hydraulic pressure. If these claims be verified, it would seem that the lightness and cheapness of the tin-lined iron pipes should render them a formidable competitor of tin-lined lead pipes hitherto used, although the latter are excellent.

# POPULAR MISCELLANY.

OF School Hygiene, very much of instructive interest is contained in a recent address of Prof. F.D. Davis, Superintendent of Schools at Negaunee, Mich. This able address was delivered at a sanitary convention held in the town named. It is significant of the progress of and present interest in sanitary science, that a convention of this kind should have been held in a young Western town of 6000 inhabitants. The subject of hygiene in schools as related to ventilation and many other things was very thoroughly discussed by Prof. Davis, all with special reference to the charge so often made nowadays against schools that the health of pupils is broken by overstudy. As against the truth of this charge, Prof. Davis avers that in ten years' experience, he has never seen a case of broken health that he thought was caused by overstudy alone; and he avows his belief that such a thing would be unheard of if the work were done under proper hygienic conditions. He cited in support of his proposition that mental work is healthful and invigorating, even when of a protracted and laborious character, the records of such men as Gladstone, Bismarck, Blaine, Bancroft, Longfellow and Lowell. He might have added Humboldt, Darwin, Franklin, Prof. Thompson, and many others, who have lived to good old age with minds active, and working to the end, but it may be questioned whether the citation of exceptional cases like these prove that mental work cannot be carried to excess with the average man, since so many men have broken down under it whose habits of life and sanitary environment were, presumably, as good as those of the eminent men named. However, the point aimed at in the address, that good sanitary conditions are essential to endurance under mental work, may be said to have been well sustained in the address.

The Wire Worm which annually inflicts enormous damage upon our grain crops appears to be a very persistent pest. A recent report of the Agricultural Experiment Station at Cornell University gives an account of a long series of experiments instituted to determine whether any means exist for the extermination of this worm, and if so, to discover the best method of combating its ravages. Attention was first directed to the protection of the seed. A coating of Paris green and flour utterly failed. A coating of tar was practically a failure. Soaking in a solution of salt was a total failure, as was also the soaking in copperas solution, soaking in chloride of lime and copperas solution, soaking in kerosene oil, soaking in turpentine and soaking in a strychnine solution. The next attempt was made at the destruction of the larvæ or the worms themselves. This was attempted by starvation, two methods being respectively adopted to effect this result. In the first method the ground was kept in fallow, but it appears that the worms found sustenance enough in the decayed vegetable matter in the soil to sustain their existence for so long a time as to render it inadvisable to attempt their destruction in this manner. The second mothod of starvation, that of the growth of supposed immune crops, failed for the same reason that the keeping of the ground in fallow failed. The crops grown during the experiment were buckwheat, mustard and rape. The destruction of the worms was then sought by the use of insecticides. Of these kerosene oil and crude petroleum, used both in a pure state, and in the condition of an emulsion, were tried without success, as was also bisulphide of carbon. Poisoned dough was found to be eaten by the click beetles, which are the parents of the larvæ, but as a destroyer of the worms it ignominiously failed. Certain substances that also act as fertilizers, as salt, kainit, muriate of potash, lime, chloride of lime and gas lime also failed. The results of these experiments have shown that the efforts at the destruction of this pest must be directed to the killing of the click beetles and the pupæ, and that this can best be accomplished by fall plowing and

trapping. Two methods are suggested for trapping the click beetles; one is by the use of baits and the other by lanterns. The best baits have been found to be sliced potatoes, wads of green clover, corn meal dough and corn meal dough sweetened with sugar. These baits are placed under boards in various parts of the infested fields. Clover was found to be the best bait. Twelve traps baited with it and left undisturbed for three days attracted 500 of the beetles which are easily destroyed when the boards are turned over. It was found also that other beetles besides the click beetles were attracted by these baits. The lantern traps attracted so few beetles that they may be regarded as of no practical value.

The Drexel Institute, of which only a general idea is conveyed in the address of Hon. Chauncey Depew, printed in our February number, will afford such facilities for technical instruction that a detailed account of them will be useful. The building is at the corner of Chestnut and Arch streets, Philadelphia, Pa., the principal entrance being on Chestnut Street. The library, reading-room, museum, lecture-hall and auditorium occupy the first floor. The lecture room seats 250 pupils. The auditorium will seat 1500 persons. The second and third floors and the basement contain 32 class-rooms, the physical and chemical laboratories and the workshops, the latter occupying the basement. The fourth floor is occupied by a large gymnasium with dressing-rooms and bath-rooms. The building is heated by steam and lighted by electricity. There are eleven departments in all, including the Art Department; Scientific Department; Department of Mechanical Arts; Department of Domestic Economy; Technical Department; Business Department; Department of Physical Training; Normal Department for training teachers; Department of Lectures and Evening Classes; Library and Reading-Room, and the Museum. Besides the regular courses, an optional course of study may be pursued, and other departments will be added as need for them is developed. The evening classes begin in October and continue to April. Drawing, designing, modeling in clay, wood-carving, mathematics, physics, chemistry, applied electricity, wood-and-iron working, cookery, millinery, dress-making, stenography and typewriting, book-keeping, etc., are among the branches that may be pursued. The museum already contains a collection of wood and metal work, ceramics, embroideries and textiles obtained by purchase, and the collection has been enriched further by contributions from Mr. George W. Childs, the family of the late Lieutenant Allan G. Paul, U. S. N., and Dr. Edward H. Williams. The fees are low, and will all be devoted to the extension of the work of the institute. Students are required to pass examinations to qualify for admission, and to supply their own text-books. In the regular and special departments there will be a system of free scholarship for graduates of other Philadelphia schools. So has been organized and inaugurated another example of public beneficence on the part of an eminent and wealthy American citizen.

A New Life Belt composed of reindeer hair confined in canvas sheathing is described in foreign journals. This belt is said to be much lighter than cork, two pounds weight of it being able to support in water 23 pounds of attached iron. The reindeer hair is said to be hollow, filled with air and impervious to water, and its immersion for any length of time does not reduce its buoyancy. On account of these valuable properties it is recommended for use as stuffing for ships' mattresses, chair-seats, sofas, etc. Coats, waistcoats or travelling-rugs may also be formed from it. All these things would be available as life-saving appliances in case of a sudden emergency at sea compelling passengers to escape hurriedly from a vessel. It is said that a large quantity of this hair is obtainable from the reindeer-skins exported from Norway, Sweden and Finland.

The Relation of the Tin-Plate Industry to the general export trade of English products, has been exhaustively discussed in a recent issue of *Industry* (London). That able journal points out that the manufacture of tin-plates depends much more

largely than most British industries upon export trade. It says, that comparatively a small proportion of the tin-plates manufactured, are retained for home consumption. It estimates that at least eighty per cent. of the output is shipped to foreign parts. Its view of the future of the tinplate industry in the United States can hardly be suspected to be influenced by considerations of American politics, and as coming from an authoritative English source, it is extremely interesting.

"The total exports to all other countries besides the United States have within the last twenty years increased from 24,500 to 100,600 tons, while the exports to the United States have increased from 75,000 to nearly 350,000 tons. It will, in any case, take a considerable time for the United States to manufacture for themselves as much as 300,000 or 320,000 tons of tinplates a year, but if the present rate of duty is maintained they are likely to do so before the business is ended. At this moment tinplate works are being built in every convenient center throughout the United States—in New York, Pittsburgh, St. Louis, Cleveland, Chicago, and even Chattanooga, in Tennessee. These works will mostly, within another year, be producing tinplates on a more or less extensive scale. A large capital has been raised for the purpose of establishing the new industry, and there is no good reason to suppose that any technical difficulties in the way of its ultimate success cannot be speedily overcome, especially as the pioneers of the industry are importing skilled labor from Wales. The latter district is meanwhile building upon the fact that the United States cannot produce tinplates as cheaply as this country, and that the present tariff is likely to be so far modified as to allow of Welsh tinplates being again imported under favorable competitive conditions."

The admission is made however, that the tariff "is always a 'dark horse,'" but it thinks that if the works be once erected some provision will be made in future tariff legislation to prevent the total loss of capital that would result from their extinction.

The Investigation of the Relation between Drinking-water and the Propagation of Disease authorized in the State of Massachusetts under a liberal appropriation will, when completed, probably give more reliable data than have hitherto been available on this important subject. The investigation should also extend to natural ice, which, as pointed out in Mr. Leicester Allen's article on ice-machines printed in this number, may serve as a vehicle for the transmission of organic matters, as well as germs not destroyed by frost. Should the same course be pursued in other states, an accurate knowledge of the conditions that render potable water wholesome or dangerous might be expected to be secured. As it is, our knowledge is meager, and beyond the fact that certain bacteria known to be dangerous, as that of cholera, and of typhoid fever, are known to be transmitted by water and that the presence of some chemical substances indicate a dangerous condition, there is yet a *terra incognita* that needs exploration.

Vegetable Oils are, according to the *Journal of the Society of Arts* increasing in demand throughout Europe, notwithstanding the increase in the use of the electric light, gas, and petroleum oils. In consequence of this demand new sources of supply have been sought and discovered. Africa has been found peculiarly rich in oil bearing plants and trees and many new oil seeds have been brought from the western coast into the English market within a few years.

The Shape of Smokestacks formed the basis of an issue between a western manufacturing company and the New York, Chicago and St. Louis Railway, in a recent suit brought to recover damages from a fire caused by sparks from a locomotive. The fire burned a building upon which an insurance company paid $50,000 insurance and then joined with the owners in the suit against the railway company, alleging that the diamond smokestacks used on the railway are inferior in point of safety to the straight stacks and extension fronts, the latter being more efficient in the arrest of sparks than the diamond smokestack. The railway company was therefore, on the part of the plaintiff, alleged to be liable for the damage caused by the fire, and the case was tried on this issue. The expert evidence of engineers and superintendents of motive-power did not sustain the plaintiff's contention, as, while admitting the superiority of the straight smoke-

stacks and extension fronts in the points of cleanliness and economy of fuel, they denied any greater efficiency for them as spark arresters. The suit therefore resulted in favor of the road.

What Kills Oysters in the large oyster-beds, where they are sometimes exterminated after a long period of successful cultivation, has often been a puzzle, not only to owners of the beds, but to naturalists. That this may be sometimes the effect of the presence, in the water, of some minute deleterious organism, seems probable from an account given in *Nature* of what occurred last spring in Port Jackson harbor at Sydney, Australia. The citizens, astonished at a sudden discoloration of the water that gave it the appearance of blood, found the cause of the singular phenomenon to be the presence of incalculable millions of a minute organism. This, upon very careful examination by the naturalist, Mr. Thomas Whitelegge, proved to be a new species of *Glenodinium*. In a paper written upon the subject, and preserved in the records of the Australian Museum, Mr. Whitelegge estimates, that one-half of the fauna of the water near the shore was destroyed by this organism, and that the destruction of *bivalves* was almost complete. What causes these occasional and remarkable multiplications of the lower orders of living things, an instance of which, long to be remembered, occurred in our own country in the descent of the Colorado beetle upon the entire Atlantic slope, often eludes a satisfactory answer. The Australian phenomenon, and the advent of the potato-bugs, are striking examples of the never-ending conflict between animal races by which, in nature, the weaker are eliminated; and they teach us, further, that mere relative size is only one element of strength, since individual physical force may be conquered by fecundity, or by superiority of some other kind. Were the physical force of men their only resource against other living beings contesting the right to live, the human race would, long since, have become extinct. The exact way in which the Glenodinia exerted such a deleterious effect is not yet fully determined.

Of Peary's Arctic Expedition, of Peary, and of the proposed expedition for the rescue of the party, the *Illustrated American* thinks that since the necessity for it is admitted, "no one will object to the relief expedition." But the journal quoted recalls that "Mr. Peary sought, before his departure, to inspire the belief that the difficulties encountered by previous Arctic explorers would be avoided in a large measure. After the expedition started it was discovered that he had taken too rosy a view of the prospect. His arrangements were not so complete as they should have been; so simple a matter as obtaining the co-operation of the Danish Government, and the assistance of the officials in Greenland, had been overlooked. When the party that accompanied him to Greenland returned, grave apprehension for the safety of himself and his companions was felt. And the feeling of apprehension becomes intensified when it is remembered that one of the persons thus subjected to unnecessary risks of suffering starvation, and perhaps death among Arctic snow wilderness is a woman, Mr. Peary's brave wife." How is it that in the fitting out of exploring expeditions nearly always some essential to success is overlooked? It is rare to read an account of any similar expedition without finding some important omission recorded, and this fact is only to be accounted for by a sort of blind enthusiasm on the part of their projectors and a trust in luck that leads them to a neglect of needed precaution, defective preparation being discovered too late to be remedied.

Cinnamon is stated by M. Chamberland, a French scientist, to be one of the most powerful antiseptics in existence. He has been making experiments with it in the laboratory of the celebrated Pasteur, and is alleged to have stated that its destructive power upon microbes is fully equal to that of corrosive sublimate, even its scent being sufficient to kill them. If true, this is a most important announcement. Its confirmation or denial is awaited.

Chinese Tin in the form of ore is said to have been shipped recently from Hong Kong to Sydney, Australia, where the metal will be extracted.

# MACHINE-SHOP NOTES.

*By Col. Loquial, M. E.*

SOME time ago one of the most noted machine shops in the world had to make some gear-wheels that were more than unusually perfect in their division. In order to get a dividing wheel they filed up 180 pieces of metal, each to represent a tooth or division of the rim of the dividing wheel, and clamped them together about the rim. Good results were got, owing to the extreme care taken with the work, doing it in a room of absolutely even temperature, and working to a micrometer caliper. But it seemed to me that it was going about the thing "wrong end to." A man out in Cleveland had the same problem to solve and he did not do it that way. He hadn't the workmen able to do it, anyhow. He just went to an armory floor and struck a big circle on the floor, with a known radius. Then at the center of this circle he set up a little drill press and a theodolite. Around part of the circumference of the circle he set up a scale marked in inches. He sighted one of the graduation marks, clamped his drilling machine to the index plate that he was going to set off, and drilled a hole. Then he unclamped the drill, the instrument, and the plate, sighted along enough inch marks to bring him where he wanted to be, in degrees, clamped his drill and theodolite to the plate, and drilled another hole; and so on until he had gone to the end of his arc. Then he shifted and started over again. When he had got all the way around he found that he struck his first hole.

A line of sight is the straightest line that can be had, and does not warp so readily as some other things of which I know.

* * *

I have been much amused at seeing that Johnson fellow cut gaskets out of sheet gum. In the first place he doesn't know how to lay them out. He cut the inside circle out first and then did not have any center by which to strike the outer circle, which he had to make as the Irishman played the fiddle, "by main strength and awkwardness." In the second place he went on cutting with a knife which made very little impression upon the rubber, when if he had just wet the blade with potash and water, or even with ordinary every-day water, such as he feeds into his boiler, he could have cut it about twice as easily. Then after he got his misshapen ring cut out, he clapped it without any further preparation between the surfaces of which he was going to make a steam joint. In about a week it will be very neatly cemented to both surfaces, so that when he wants to break that joint he will in truth "break" it; for that gasket will not be likely to serve again. Part of it will be on the boiler shell and part on the man-hole-plate. If he had known enough to chalk one side (or better yet to black-lead it) when he wanted to break the joint he would have found that the chalked or the black-leaded side would free itself from the iron just as though it was greased.

* * *

There seems to be considerable of a controversy about the inventor of the monkey wrench. Some say that his name was Charles and others that he was Thomas; all agree that he was a benefactor to the race of mechanics—but the English call the thing itself an "adjustable spanner," and cheat him (Charles or Thomas, it is all one at this date) out of the credit which is due him. But what I want to know is who invented the pipe-tongs. I want to find out where he is boarding, and then I want to go and stamp on him, and give him my opinion of him. Why is it that their jaws are all out of true, even when they are new; that their handles spring; that they fit only about one size of pipe with any degree of decency, and are not satis-

factory even then? Why did not the pipe-tong man finish the invention and give us tongs that would grip, or else let them alone?

For my part, there is only one thing that I hate worse than a pair of three-quarter-inch pipe-tongs, and that is a pair of inch-and-three-quarters.

* * *

After several years of experiment, more or less costly, the great American tool-using public is beginning to wake up to the idea that you cannot make machine-tools out of filler and stone-finish. It has been tried and found wanting, but no longer wanted. Machine-tool users have given hints to builders to put in a little more iron and a little more iron still, and builders have thickened up their patterns and stiffened up their shafts, lengthened out their journals and bearings and stretched their slides, and so on all the way around until their tools are in one sense like the boy's knife that had had five new handles and seven new blades. But they have the virtue that they stand up under their work and enable bigger and better work and more of it to be done, than used to be the case.

* * *

Apropos of files and their work, it is strange that an American invention, the sand-blast, has taken hold so well in England and on the continent of Europe for file sharpening, and seems to have been practically neglected on this side, in the same connection. If you will look at a new file you will find that there are on the ends of the teeth certain small hooks, and these correspond to a wire edge on a knife or a razor. Of course they are not desirable; but there is no way of making file-teeth with a chisel, particularly if it is held by a machine, without having these same hooks. The sand-blast cuts files without such wire edges, and re-cuts old ones better than they can be done by hand; and many English establishments have their new files given a little sand-blasting before they are put in service; the object being to give them better cutting edges than the makers turn them out with.

I see that you have been buying files of Judkins, and I know why you bought them—because you save something on the first cost of every dozen. But if you will take some of those 14-inch ones which you have just bought and weigh a dozen of them alongside of a dozen of the old ones of the same length, face, and cut, you will find that there is about one-fourth to one-third less metal in the new ones. And if you figure it up that you can at best get only one re-cutting out of them, and then will have only some scrap steel about, you will find out that it pays to buy the heavier files at five per cent. or even ten per cent. higher price. Besides this, if you will let the old ones in the shop have their choice of the two, you will find that they will prefer the old kind, because they take hold better and require less elbow-grease back of them. It is a pretty fair indication of the value of the steel in a tool, to let the piece-work hands have a chance to use it or let it alone. The tool that requires frequent re-sharpening is the one that the piece-work hands don't like; and the file that requires biceps to make it do its work, instead of biting in to the work as if it loved it, is the one that the piece-work hands and the "old boys" about the shop will let severely alone as soon as they find it out; and it doesn't take a man long to find out such a thing as that.

* * *

They had a sad accident over the way, and one that might just as well have been here for all the precautions that you have taken to prevent the very same thing happening. A man was fixing a belt-shifter, and his sleeve caught in a flange coupling, and his arm was torn out of its socket before help could get to him. He will die, of course. Every one of those nuts which sticks out from a plate coupling invites accident. I don't see why people will stick to such barbarisms. Considered as couplings they are not a success. They are big, heavy, and expensive, and take time to put up and time to take down; and half the time when you try to take them down you find that they have rusted together. If a belt gets thrown off a pulley, and its edge

strikes one of them, it is ruined; and if it is a rubber belt that is the end of it; you can't even cut it down and make a narrower one out of it. And in case of some poor devil's sleeve or what is worse, some poor girl's hair—getting caught, there is a horrible accident which no mere money can measure, no mere money can pay for. If people will put up such abominations, they should be compelled to case them in, or to have them so constructed that there are no projecting parts like bolt-ends. Any one who has ever used a compression coupling knows how much more handy it is than the other—that is, if you get the kind that can be taken down as readily as it is put up; some of them are easy to screw up and difficult to take off; they are like lobsters, that are said not to let go until it thunders or until the sun goes down.

* * *

There is a "dim religious light" over in the northwest corner of your shop, and it seems to me that it takes the men about seven times as long to make an adjustment or to read a measurement as in the corner diagonally opposite. Your pattern shop wall comes close to the window in the dark corner, and you have outside a wire screen that was put on years ago before the pattern-shop was built, to keep boys from breaking the windows. Inside that wire screen there is a coating of grime and dirt that is just as old as the pattern shop—about five years if I remember rightly. If you will take down the screen (which is of no use) that will give you a trifle more light and give you a chance to send a man outside with a hose and a brush and wash down the windows; and then if you will send a man out with a bucket of whitewash, a wide brush, and suitable instructions to brighten up both the walls that face each other in that manner, you will have light reflected into the shop, and the men will be able to see whether a thing is eleven thirty-seconds or three-eighths. In this country, at least, sunlight costs practically nothing; why not use it and plenty of it, particularly when your men want it and are losing time for lack of it? If there comes in too much for their eyesight they can put up a temporary sheet of brown paper; but I guess that in that particular geographical corner, and as long as the pattern shop stands there, there will not be any blinking, especially of afternoons.

* * *

Quite a commotion in one of your shops as I came along. Emery wheel burst and took a piece of the wall with it as it went out to look for a shop where they know something about such things and how to use them. Your foreman says that that is the second wheel that has burst with the same man; and that he seems to be a sort of a hoodoo in that particular. Well, I don't think that there is any luck about it. If that man had gone on running emery wheels the way that he has for the last six or seven years, and had not had a few of them burst, I should have considered it luck, and much better luck than he deserved; but for him to have had two wheels burst in your shop, besides the couple or so that he had fly all over the face of the earth when he was working for Adams—I consider that only retribution, or dead certainty, or whatever is most opposed to luck and most to be expected from certain regular causes. Perhaps you are to blame for it a little, perhaps he is to blame entirely; but I would see to it, if I were you, that no more burst in your shop. The next time one lets go it might break just the other way and fly through you or some of your employés instead of just through the wall and into the scrap-heap. That man gets about as tapering a mandrel as he can find; then he crowds the wheel on it so tightly that the cone of the mandrel has a tendency to break the wheel apart; and then he runs the wheel as fast as he can get it to turn, and wonders that with the wedging action on the inside and the so-called centrifugal action all through it, particularly at the rim, it flies. If he will take a parallel mandrel that is of the same size as the hole in the wheel, and will put some thick paper between the collars and the sides of the wheel, he can hold it centrally without any such tapering nonsense, and if it doesn't run true it can be made to so so in about five minutes, by a diamond-point.

If the makers of that wheel, and of other emery wheels, had thought it best to use tapering mandrels with them, they would have had tapering holes through them; they would have been much more easy to make. But they thought that by putting a cylindrical hole in each wheel, the user would see the point and use a cylindrical mandrel.

* * *

That boy doesn't seem to have anything particular to do. There is really no job on which he can work. Well, tell him to go to work and turn a cube on his lathe. See how long it takes him to get on to the idea that a lathe can be made to do anything in this world if you only know how to set it. When he learns that the only plane surface that is ever made in wood-working is made by a rotating pair of arms on the Daniells planer, he will perhaps think further and discover that the poorest way of making a plane surface is by a to-and-fro cutter.

* * *

When I see a machinist deliberately washing his hands in lard oil sooner than use a little more soap and elbow grease, I have my opinion of him. I do not think that he is likely to be very economical and energetic about shop matters. The little things tell. When I see a man do that I conclude that he will use waste as freely as if it was only ten cents a ton.

* * *

I've been having a good deal of fun watching my neighbor open out a piano-case. He got a nice $1000 upright piano, well-packed for shipment. When it reached him he set to work to open it out. He found that he was reckoning without his host. The piano was very properly done up in a frame of stout 2 x 4 stuff; there was not a screw used, less than six inches long; and some of them, which screwed the case of the piano to the crate or box, were eight inches. There was not a screw-driver about Hurst's house that would turn one of those screws. A brace did not help him any. The old trick of expanding the head of the screw by a hot iron did not work in this case. The box had to be chopped to pieces; and it was not good chopping either. Now if whoever put in those screws had just dipped them first in oil and then in black lead before he drove them, they would have backed out about as readily as they were driven in; and the recording angel would have made fewer entries opposite Hurst's name.

* * *

As long as you go on in the way that you are, in planing up those big iron plates, you will not get one of them straight. You cast them about six feet by four, and an inch and a half thick, and then you plane off a thirty-second and scrape them, and wonder that they are not flat. They mean to be flat, but they can't. You have taken off the skin from one side, and that makes them curl; and all the scraping and filing that you can put on them in two days will not make them be straight and stay straight. If you will take the thirty-second off each side you will find that they are in about the same condition of tension on both sides and will stay reasonably flat and straight; then all that you have to do with your scraper is to correct any high spots that may exist by reason of the metal having been hard in spots and resisting the planer tools. You will save it by doing intelligently by cheap labor on the planer, what you are now paying a high-priced man to do with infinite pains and skill against the heaviest odds. That man is a good bench-hand, and is doing his share of it with a skill that you will find to be very rare in these days; but it is not his place (as he sees things) to tell you how you may dispense with about seven-eighths of his work and get the plates done in half the time that it now takes.

* * *

"What does this mean, out of the *Twentieth Century?* 'Behind the ultimate large and ultimate small, ignorance postulates a larger something and a smaller something (which, however, is nothing) which it insists can do all with ease which the larger and the smaller cannot do.'" I think that that is a bookworm's or a quack's way of saying that ignorant people try to persuade themselves, or you, that a house is longer inside than out; that you can get five silver quarters for a paper dollar.

# COMMENT & CRITICISM.

## Mr. Pentecost and His Critics.

WILL you do me the kindness to republish in your pages the following editorial article from the New York *World*, for the benefit of those of your readers—particularly newspaper editors—who criticised my article entitled "The Tap-Root of Industrial Discontent" (July, 1891.) as having no application to current industrial affairs, and no practical value in the real work of social improvement:

THE COAL MONOPOLY.

The consolidation of the four coal-carrying railroads completes a monopoly which has been in process of formation for years.

It gives to a single organized group of men practically absolute control of the entire anthracite coal product of America.

It empowers these men to determine how much coal the miners shall take out of the ground, for how many days in the year they shall have work and wages, and for how many days they shall be impoverished by idleness.

It enables them to fix the price of anthracite coal without reference to any law of supply and demand and without consideration of the cost of production.

It authorizes these men arbitrarily to increase, diminish or completely cut off the supply of coal to great cities and to factories that employ thousands of workmen. In a word, these men have seized upon the whole of one of the country's most important natural resources. They have made exclusively their own a vast natural wealth which should minister to the prosperity of all. They have cornered the resources of the everlasting hills.

That such monopolizing of natural resources is evil and dangerous there can be no doubt. Or if one be in doubt he has only to reflect upon the inevitable result of doing the same thing with respect to other resources that are the common heritage of men. The logical outcome of the monopolistic party is the concentration in the hands of the few not only of all wealth but of all the means of producing wealth, and the reduction of the rest of mankind to a slavery not the less actual because it is called by another name.—*New York World*, February 14, 1892.

In my article last July, referring to the strikes in the coal regions of Western Pennsylvania, I said:

"The region in Pennsylvania which was the scene of this disturbance is specially characterized by the richness of its coal deposits. Vast stretches of territory, extending in almost every direction, are underlaid with deposits of coal sufficient in quantity to supply every possible demand for centuries to come. Here and there an opening in these deposits has been made and is industriously worked; but in the main, this vast mass of raw material is held securely in the hands of the companies who are operating the few mines that have been opened, and the privilege of unearthing it is held at so high a price that it is practically prohibitive. Indeed, it is a fixed policy among successful mine operators to secure the control of coal deposits liable to come into competition with them, for the double purpose of commanding a higher price for the product of mines that have been opened, and of keeping down the wages of the limited number of miners employed.

"Suppose that these *limitless opportunities for labor* were open to the use of miners who are discontented with the wages now paid by their employers. Would there have been any likelihood of such violence as we have seen? Would not the discontented miners have quietly turned to the use of the opportunities about them?

"The occupation and use of land—call it 'possession' or 'ownership,' as you like—is not a social injury; but the exclusive control of land not in use, the dog-in-the-manger ownership of land, so to speak, is the greatest of all social injuries. * * * I am not a believer in patent social panaceas. Social improvement will only come about by the evolution of individuals, the general diffusion of knowledge as to what is necessary to human welfare. But it is clear to me that a necessary part of such individual education is to know that industrial discontent will prevail as long as it is permitted for certain men to hold a large part of the earth out of use to the exclusion of other men who would, if they were allowed, put the now vacant earth to productive use. * * *

"Discontent will not disappear until vacant land is free. Vacant land will not be free until public opinion demands it, and visits on the vacant-land owner the social ostracism which now falls on the professional criminal. Public

opinion forms slowly, but it does form, and it has a tendency to form in beneficial directions. Countless ages passed before a despotic ruler became impossible in a few nations, before a waiter in a restaurant was allowed to dress exactly as the most socially exalted person in a nation, but the time for these things finally came. And so may the time come when an owner of vacant land will be as disreputable as the owner of a chattel slave would be in some parts of this country to-day.

"* * * To insure a fair distribution of wealth and personal freedom, *land must be held only by occupancy and use.*"

HUGH O. PENTECOST.

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### Common Country Roads.

AN article on this subject in the November number of this magazine was very good, but about the same date one appeared in another monthly which seemed to me decidedly objectionable, and as it probably met the eyes of others of your readers it may be referred to here. The point made was in attacking the railroads for furnishing cheap transportation to the "capitalists" and manufacturers, while the "poor farmer" was utterly neglected.

Mr. Edward Atkinson has shown clearly that the great trunk lines within a few years have reduced the cost of freight from Chicago to the seaboard from 2½ cents to about one-half a cent per pound, and that the much-abused "monopoly,' The Standard Oil Company, has materially cheapened the cost of oil to all the consumers and exporters along the Atlantic coast. These two examples may suffice to show how the great railroad systems, all the country over, have universally lowered prices to the consumer, while in many cases raising them to the producer.

But the point I wish to make is, that the railroad system has reached its limit of usefulness in the more thickly settled parts of the country, and other means must be resorted to in order to carry out the subdivision of its benefits, and enable them to reach the producers at home. This must be by the improvement of the common highways. A railroad costing from $30,000 to $60,000 a mile cannot be run into every rural district or to every farmhouse; the traffic would not pay running expenses alone.

It is common for writers nowadays to refer to the old Roman roads, and the roads constructed by the first Napoleon, but it must be remembered that these were great "trunk-lines," and the prototypes of the railroad of to-day. They were built by imperial dynasties, with capital taken from the people by taxes, yet the work was so wisely done that the money reverted to the people in the reduction of their expenses in using the roads. With us the case is reversed, and the money, which as before comes from the people, is also expended by the people, and what seems to be the pressing need of the day is the diffusion of such education and information among the people as to enable them to expend this money in the wisest manner.

We know how the Romans built their great trunk-lines of road, but we do not know how they managed with the small branches and feeders. With France it is different, for their system is still in existence and is carried out in detail all over the country. They have a national school —"L'Ecole des Ponts et Chaussées"—in which engineers are educated, and under their direction all public works in that country are constructed. Our only institution of the sort is the West Point Military Academy. Although the cadets there are taught road and bridge building, yet after graduation the great majority of them enter military life, while the few who drift out, or resign, are usually drawn at once into the employment of railroad or other corporations. One of the great needs of our time is a school which shall educate skillful engineers for the ordinary duties of life.

The strong feeling of opposition to centralization so prevalent among us might prevent the establishment of any such national school, but here our various scientific schools might come in and add to their present curriculum a year's instruction in practical road and bridge building. Such schools might provide the proper engineers to supervise and direct such work, or to give sound advice when called

upon, but the execution of these works, which reach the people directly in the remotest parts of the country, must be left to the people themselves, as it now is, with this difference: that through sheer ignorance of the proper ways and means, much of the work of road-building and repairing is very badly done, and at a greater ultimate expense than would be incurred to do it properly.

Each State might appoint a properly-educated man as State Engineer, to have the direction of all State work, with advisory power in minor matters. He might have an assistant engineer in each county, to be selected and paid by the county, to superintend local works, with the right to call in the chief when necessary. Finally, each town might appoint a proper man to be highway surveyor, whose tenure of office should depend only on good behavior and ability to perform his duties, to be paid a fair compensation by the town.

The practical labor of the care of the town roads would fall on the Highway Surveyor of the towns, and he should be familiar with the location of all the ledges and gravel beds in the town. While in most cases the broken-stone roads of Telford and MacAdam would be impracticable, for the want of the cheap labor, such as the writer has often seen in Europe, cracking up the cobble-stones and pebbles with light long-handled hammers in many of the larger towns, it would be economical to invest a few hundred dollars in a portable boiler and a "Blake Crusher," and keep them at work during the summer on the outlying roads, breaking up the loose stones and piling them in heaps for the repairs of the following spring.

Nature has, however, in the Northeastern States provided a material to save much of this labor, namely, the great deposits of "hard pan" and gravel, the scourings of the great "ice age," which she has deposited in profusion all over the country. In the valley of the Upper Connecticut the "blue gravel" is from a slaty formation, packs close and hard, and makes a road as "smooth as a bowling alley." It is the same over most of the State of Vermont, while in the lower valley, where much of the gravel comes from the red sandstone, it is sandy, and non-adhesive. The same may be said of the gravels of the lower Merrimac valley, ground down from the granitic rock of that section, which, although better than that from the sandstone, lacks the cohesiveness of that from the slate.

One point to which the writer wishes to call attention, and against which he desires to enter an earnest protest, is the old custom of allowing every man "to work out his highway taxes" on the roads in his own fashion. It is a survival of a custom, once a necessity, when there was no community and everybody had to make his own road. A practical illustration of it came under the writer's notice last summer. The main road from this village to the next town east of us rises steadily for four miles, with a moderate grade most of the way, but with a few sharp pitches most of which have however been graded down in past years, and well gravelled from the very roadside so that except the ascent, say 200 feet to the mile, it is a very good road to drive over. Last summer a farmer living on this road, three miles from town, was allowed to "work out his taxes" on a half mile of one of the grades beyond him, over which he had little occasion to travel, and the writer had the misfortune to drive over the road a few days after it was "mended." A plow had been just run along the ditches at each side of the road, breaking up all the grass and weeds, and small bushes which had grown in the mud washed off the road-bed, by the rains and melting snows, of the preceding season, and then a Western "road machine," like a reversed snow-plow, which the town had imported from some region, where, as the saying is, "you may go miles to find a stone to throw at a dog;" had been put into service, and all the weeds, sods, mud and roots piled up into a high crowning ridge over which or through which it was almost impossible to steer a light wagon with safety, and comfort was out of the question. Later in the autumn I drove over the road again; the mail stage, and farm carts, from beyond, had pounded the

sods down, so that the track was quite smooth, but what will it be next spring? The melting snows and the spring rains will wash off the decayed grass roots and mud, and the road will be worse than before! Now here was plenty of hard gravelly soil all about, which might have been used, and a good road made, which would have *lasted*, but it would have taken a little more trouble, and the man did not know any better, but did just as his great-grandfather did before him, in making a road to his wood-lot!

With such roads, made and supervised under some such general system as I suggest, the farmer will get his produce to the railroad as easily as the railroad now gets it to the market. SAMUEL WEBBER.

Charleston, N. H.

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### The First Manual-Training School.

THE address of Dr. Chauncey M. Depew at the Drexel Institute, which is published in this magazine for February, contains the following statement:

"It is a remarkable illustration of the failure of the schools to divine and meet the changes of the century, that the first suggestion of a manual-training school came from Victor Della-Vos, Director of the Imperial Technical School of Moscow in 1868."

Coming from such eminent authority this is certainly a remarkable announcement and lends color to the oft-repeated statement that the people of our Eastern States do not always understand or appreciate the untiring energy and wonderful progress of their Western neighbors.

The movement for the better education of the industrial classes began in the State of Illinois as early as 1851 and resulted in grants of land from the General Government to the several States in 1862. The Illinois Industrial University, located at Champaign, Ills., was chartered in 1867 and was equipped from the start with shops and farms where the practical side of mechanics and agriculture was used to emphasize and illustrate the principles taught in the books. Chemical symbols were made tangible and the intricate formulæ made real by combining the elements in a laboratory well provided with chemicals and experimenting apparatus. In the physical laboratory the apparatus was largely made by the students themselves. In the shops the student not only "practically ran the boiler and the engine" but constructed every part from the drawing to the completed work.

Believing that this was the pioneer in the new education I hope you will give space to this brief explanation.

J. A. OCKERSON, M. Am. Soc. C. E.

St. Louis, Mo., February 9, 1892.

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### Who is an Engineer?

IN the article of Mr. Oberlin Smith on "Who is an Engineer?" he tries to fix the meaning of the titles in the different engineering branches. It may be of interest to state that the term of "civil" engineer in general opposition to "military" engineer has not been used for a long time in Europe. The prominent polytechnical institutes in France, Germany, Holland, etc., confer the title of "Civil Engineer" on those who have passed examinations in theoretical and applied mathematics, waterworks and sewerage, surveying, railroading, constructions of metal, etc., irrigation, harbors and docks, canals, etc. This is quite distinct from the title of mechanical engineer, or as they call it in France, "Ingenieur des Arts et manufactures." The civil engineers in the Government employment in France have the title of "Ingénieur des ponts et chaussées" (engineer of bridges and roads), and in Holland: "Ingenieur van 's Rytes Waterstaat" (engineer of the State Institute for the maintenance of the coast, dykes, canals and the improvement of the rivers). The word "ingenieur" is never applied to an engine-driver or stationary engineer; those men are called "machinists." I think this could be very easily adopted in general for men handling an engine. The title of engineer, like "ingenieur," ought to be applied only to scientifically trained people. "Ingénieur" is derived from "ingenieux" which means (approximately at least) "clever" or "ingenious."

A. R. W. KERBHOVEN, C. E.

Chicago, February, 1, 1892.

# EDITOR'S EXCHANGE TABLE.

## AN INDEX TO CURRENT TECHNICAL LITERATURE.

THE tabulated list contains the names of exchanges most frequently quoted. To save space the abbreviations respectively prefixed are employed in the list of articles following the index. Illustrated articles are indicated by an asterisk (*), continued articles by a dagger (†), and concluded articles by a double dagger (‡). Orders for copies of publications mentioned should be sent direct to the addresses given.

A A.....American Architect. *w.* 15c. Boston.
A E .....Architectural Era. *m.* 25c. New York.
A & B....Architecture and Building. *w.* 15c. New York.
A J R A..American Journal of Railway Appliances. *m.* 25c. New York.
A M.....American Machinist. *w.* 6c. New York.
B J C....Boston Journal of Commerce. *w.* 6c. Boston.
C A B ....Canadian Architect and Builder. *m.* 20c. Montreal.
C E .....Colliery Engineer. *m.* $2 per year. Scranton, Pa.
Cos .....Cosmopolitan Magazine. *m.* 25c. New York.
E E L ....Electrical Engineer. *w.* 3d. London.
E E N Y..Electrical Engineer. *w.* 10c. New York.
E L.....Electricity. *w.* 1d. London, Eng.
El.. .....Electrician. *w.* 4d. London, Eng.
E C .....Electricity. *w.* 7c. New York-Chicago.
E R L.....Electrical Review. *w.* 4d. London, Eng.
E R N Y...Electrical Review. *w.* 10c. New York.
E W.. ....Electrical World. *w.* $3 per year. New York.
E.....Engineering. *w.* 6d. London, Eng.
E M J.....Engineering and Mining Journal. *w.* 10c. New York.
E N.....Engineering News. *w.* 15c. New York.
F.....Forum.
I E.....Indian Engineering. *w.* As. 8. Calcutta.
I L. .....Industries. *w.* 6d. London, Eng.
I A.. .....Iron Age. *w.* 10c. New York.
I J M S...International Journal of Microscopy and Natural Science. *m.* 6d. London-New York.
Inv.....Invention. *w.* 6d. London, Eng.
J A E S...Journal of the Association of Engineering Societies. *m.* 30c. Chicago.
J O I.....Journal of Industry. *m.* 20c. San Francisco, Cal.
J F I .....Journal of the Franklin Institute. *m.* 50c. Philadelphia.
J N E W...Journal of the New England Waterworks Association. Quarterly. 75c. New London, Conn.
J S A.....Journal of the Society of Arts. *w.* 6d. London, Eng.
L E.....Locomotive Engineer. *m.* $1 per year. New York.
P A .....Progressive Age. *w.* $3 per year. New York.
P S .....Power-Steam. *m.* $1 per year. New York-Chicago.
P T.. ....Photographic Times. *w.* 15c. New York.
N .....Nature. *w.* 6d. London.
N B .. ...National Builder. *m.* 30c. New York-Chicago-St. Louis.
S A S.....Scientific American Supplement. *w.* 10c. New York.
Sc.....Science. *w.* 10c. New York.
S... .....Stone. *m.* 15c. Indianapolis, Ind.
S M.....Scribner's Magazine. *m.* 25c. New York.
R A E J..Railroad and Engineering Journal. *m.* 25c. New York.
R A.....Railway Age. *w.* 10c. Chicago.
R G.....Railroad Gazette. *w.* $4.20 per year. New York.
R M M...Railway Master Mechanic. *m.* $1. Chicago
R R.....Railway Review. *w.* 10c. New York.
Tr C E...Transactions American Society Civil Engineers. *m.* $10 a year. New York.
W E.....Western Electrician. *w.* 10c. Chicago

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*ARCHITECTURE.*

Interior Woodwork (A A–Jan 23.)

Seventh Exhibition of the New York Architectural League (The Inland Architect *m.* 25c. Chicago–Jan.)

Foundations and Floors of the Columbian Exposition Buildings (Journal of the Association of Engineering Societies *m.* 30c. Chicago–Dec.)

Transition of the American Dwelling House. Cyrus K. Porter (Architect and Builder *m.* 15c. Kansas City–Jan.)

Italian Architecture* (A A–Jan 30.)

Foundations at The Columbian Exhibition (Ibid.)

Chicago Architectural Progress during 1891 (Ibid.)

French Architecture*† (A & B–Jan 30.)

Baths and Bath-Houses (A & B–Feb 6.)

Water Closet Apparatus. L. D. Horsford (Ibid.)

Mechanical Ventilation. W. D. Snow (National Builder *m.* $3 per year Chicago–Feb.)

Experiments on the strength of Masonry Beams at Nadrai.* W. R. Williams (Indian Engineering *w.* as 8. Calcutta–Jan 9.)

Better Wood Construction*† (A A–Feb 13.)

*CHEMISTRY.*

Ether and the Transmission of Energy. Prof. A. E. Dolbear (Practical Electricity *fortnightly* 10c. Boston–Jan 16.)

The Effect of Nascent Hydrogen and Nascent Oxygen on Nitric Acid. W. F. Hall (American Chemical Journal *m.* $4 per year Baltimore–Dec.)

Solid Formulæ ; Models for use in Teaching Organic Chemistry. A. Eiloart (Ibid.)

The Application of Electrolysis to Alkala Manufacture† (Electric Plant *m.* 6 pence London–Feb.)

The Chemistry of Cements (Stone *m.* $2 per annum Indianapolis–Feb.)

*CIVIL ENGINEERING.*

A Method of Tunneling. H. Avery (J A E S–Jan 23.)

The Management of Municipal Public Works in St. Louis, Mo. (E N–Jan 23.)

The Weehawken Viaduct and Passenger Elevators * (R G–Jan 22.)

The Brazos River Harbor Improvement.* G. Y. Wisner (Tr C E–Nov.)

The Paris Underground Electric Railway. F. C. Perrin (E R N Y–Jan 30.)

The Ogden Avenue Viaduct, Chicago* (E N–Feb 6.)

State Inspection of Bridges. E. A. Hill (Railway Age *w.* 10c. Chicago–Feb 5.)

*ELECTRICAL.*

The Ancient and Modern Accumulator. F. K. Irving (W E–Jan 23.)

Generating Stations and their Physical Hazards. G. P. Low (Ibid.)

The Inventions of Henry Pinkus of Pennsylvania. A. M. Tanner (E R L–Jan 8.)

Electricity and House Building (Practical Electricity *fortnightly* 10c. Boston–Jan 16.)

Disturbing Inductive Effects of Rotary Current Installations upon Telegraph and Telephone Lines (E L–Jan 15.)

The Progress of Electricity in 1891 (Ibid.)

Electrotechnical Notation Abbreviation and Symbols (El–Jan 15.)

The Radiation of Electric Energy. † F. T. Trouton (Ibid.)

The Crystal Palace Exhibition (E E L–Jan 15.)

Telephone Charges by Meter (E R L–Jan 15.)

Electrical Features of the City of Buffalo.* Carl Hering (E W–Feb 13.)

Notes on Electromagnetic Machinery. *† W. S. Aldrich (Ibid.)

Construction of Non-Inductive Resistance.* W. E. Ayrton and T. Mather (Ibid.)

The Bell Telephone Co. of Philadelphia—its New Plant.* Geo. M. Phelps (E E N Y–Feb 10.)

Fly-Wheel Accidents in Electric Light Stations† (Ibid.)

Scribner's Method for Cutting out the Indicator Electromagnet in Telephone Exchanges E L–Jan 22.)

Electrical Appliances for Navigation (Ibid.)

Determination of the Efficiency of Dynamos. G. Kapp (E E L–Jan 22.)

The Utilization of Electric Power at the Schenectady Edison Works.* T. C. Martin (E E N Y–Feb 3.)

Mr. Tesla and Rotary Current (E E L–Jan 29.)

Magnetic Leakage in Dynamos and Motors (E R L–Jan 22.)

Prof. Geo. Forbes on the Development of Electrical Distribution (E R L–Jan 29.)

A Few Points on Dynamo and Motor Design. M. Mayer (Electrical Age *w.* 10c. New York–Feb 13.)

Electricity in its Relation to Mining. Ernest Scott (E R L–Jan 15.)

Measurements of the Power Developed by Alternating Currents in any Circuit† (Ibid.)

Determination of the True Conductor Resistance of a Telegraph Line. A. Eden (Ibid.)

Suspension and Construction of the Coil of a D'Arsonoal Galvanometer. W. E. Ayrton (Ibid.)

On New Right Hand and Other Rules. W. P. Maycock (Ibid.)

Electrical Organ Control. R. Hope–Jones (Ibid.)

Automatic and Multiplex Telegraphy.* F. N. Gisborne (The Electrical Age *w.* 10c. New York–Jan. 23.)

New Quarters of the Western Union Telegraph Company * (E W–Jan. 30.)

The Uses of Electricity in a Modern Residence.* H. W. Leonard (Ibid.)

On the Law of Hysteresis. C. P. Steinmetz*† (E W–Jan 30.)

The New Equipment of the Western Union Telegraph Company's Office in New York.* A. S. Brown (E E N Y–Jan 27.)

The Double Trolley City. N. W. Perry (E C–Jan 27.)

Some Central Stations in Germany and France. F. C. Perkins (Ibid.)

A New Electric Road Carriage.* W. S. Key (Ibid.)

Notes on the Distribution of Power by Alternating Currents.* W. Stanley, Jr. (W E–Jan 30.)

Direct Current in Long Distance Transmission. A. Dow (Ibid.)

Electric Cranes with Special Reference to the one in the Baldwin Locomotive Works. C. J. Bates (R G–Jan 29.)

Electro-Magnet Shunts. W. Moon (E R L–Jan 22.)

Electrically Lighted Vestibule Train on the

Chicago, Milwaukee and St. Paul Railroad* (W E–Feb 13.)

Postal Telegraph System of Great Britain and Ireland*† (E C–Feb 10.)

Notes on the Distribution of Power by Alternating Currents. W. R. Tobey (E R L–Feb 5.)

Niagara the Motor for the World's Fair. J. Trowbridge (Ibid.)

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The Last of the *Great Eastern** (El–Jan 15.)

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Stresses in Railway Bridges in Curves.* W. Baldwin (Tr C E–Nov.)

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Our Lake Commerce and ways to the sea. C. K. Davis (Ibid.)

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Toning Slides with Uranium Salts. A. Stieglitz (P T–Jan 22.)

Developing and Toning Bromide Prints. P. C. Duchochoise (P T–Jan 29.)

The Chemistry of Photography.† W. J. Harrison (P T–Jan 22.)

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*QUARRYING.*

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# SOME RECENT BOOKS.

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Steam Engine considered as a Thermo-dynamic Machine. London: E. & F. N. Spon Co.

Cotterill, James H., *M. A., F. R. S.*=Applied Mechanics. An Elementary General Introduction to the Theory of Structure and Machines. New York: Macmillan & Co. [8vo, $5.]

Evolution in Science, Philosophy and Art: Popular lectures and discussions before the Brooklyn Ethical Association. New York: D. Appleton & Co. [12mo, cloth, 475 p., $2.]

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Henderson, Ridley.=Data for Engineers, Surveyors and Explorers. London: E. & F. N. Spon Co. [Pamphlet, 26 p.]

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Jerrold, Walter.=Michael Faraday, the Man of Science. New York and Chicago: F. H. Revell Co. [166 p., 75 cents.]

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Marks, G. Croyden, *A. M. I. C. E.*=Hydraulic Machinery Employed in the Concentration and Transmission of Power. Manchester, England: The Technical Publishing Co.

Moldenke, C. E.=The New York Obelisk, Cleopatra's needle; with a preliminary sketch of the history, erection, uses and signification of Obelisks. New York: A. D. F. Randolph & Co. [12mo, cloth, 202 p., $2.]

Newman, John, *A. M. I. C. E.*=Earthwork Slips and Subsidences upon Public Works: Their Causes, Prevention and Reparation. Especially written to Assist those Engaged in the Construction or Maintenance of Railways, Docks, Canals, Roads, Water-Works, River Banks, Reclamation, Embankments, Drainage Works, etc. London–New York: E. & F. N Spon Co. [8vo, cloth, 234 p., $3.]

Norman, H.=The Real Japan: Studies of contemporaneous Japanese manners, morals, administrations and politics. Illustrations. New York: Charles Scribner's Sons. [8vo, cloth, 364 p., $3.]

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Ramsay, William, *Ph. D., F. R. S.*=A System of Inorganic Chemistry. London: J. & A. Churchill. [8vo, cloth, 700 p.]

Reeve, C. H.=The Prison Question: a theoretical and philosophical review of some matters relating to Crime, Punishment, Prisons, etc. Chicago: A. C. McClurg & Co. [8vo, cloth, 200 p., $1.25.]

Russell, Stuart A.=Electric Light and the Distribution of Electricity. London: Whittaker & Co.

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Sloane, T. O'Conor.=Electric Toy Making, dynamo building and electric-motor construction. Illustrated. New York: Norman W. Henley & Co. [12mo, cloth, $1.]

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Taylor, J. Traill.=The Optics of Photography and Photographic Lenses. London: Whittaker & Co. [*3s. 6d.*]

Thurston, Robert H.=Manual of the Steam Engine. Part II.—Design, construction and operation. New York: John Wiley & Sons. [8vo, cloth, 23–937 p., $7.50.]

Vosmaer, Augustus.=The Mechanical and Other Properties of Iron and Steel in Connection with Their Chemical Composition. New York: E. & F. N. Spon Co. [12mo, cloth, 203 p., $2.50.]

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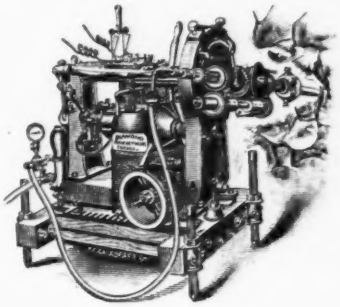
### Improvements in Methods of Prospecting Mineral Lands.

ONE of the most interesting features of the advancement in mining processes is the constantly increasing use of the diamond drill for prospecting mineral lands and developing mines. By means of the solid core of rock and minerals removed by the diamond drill, a knowledge of mineral property can be obtained equal to that gained by a large number of shafts, tunnels and cross-cuts; and as the cost per foot of drilling is trifling compared with that of shaft-sinking, tunneling and cross-cutting, and its progress so much more rapid, the tendency is, by its use, to explore properties more thoroughly before opening them up, and more completely while developing them, thus reducing considerably the element of uncertainty connected with the old method of prospecting. The increasing favor in which the diamond drill is held among mining men is especially marked in Colorado, where twenty-five or thirty leading mining companies have purchased "Sullivan" diamond drills within the last two or three years, to be used in formations where it was formerly supposed they could not be used to advantage. Several remarkably rich discoveries of ore have been made in Colorado, with the "Sullivan" drill, as at Aspen, Leadville, and Red Mountain.

As the use of the diamond drill has been extended to all branches of prospecting work, new styles have been built to meet new requirements. The latest "Sullivan Diamond Prospecting Core Drill," is designed for either surface or underground work, and will be found especially convenient where it can be used first for examining new property, and afterward for developing the mine and locating new ore bodies. It has a hoist and frame, for convenience in surface work, and the "friction" feeding device, used on some other types of Sullivan diamond drills, which is the safest, most economical and most compact, for use in underground work.

Another recent design of the Sullivan diamond drill is shown in the cut of the "R" drill, on this page, operated by electricity. This is the only electric diamond drill in practical and successful operation, several of the best equipped mines at Aspen, Col., and other western camps,

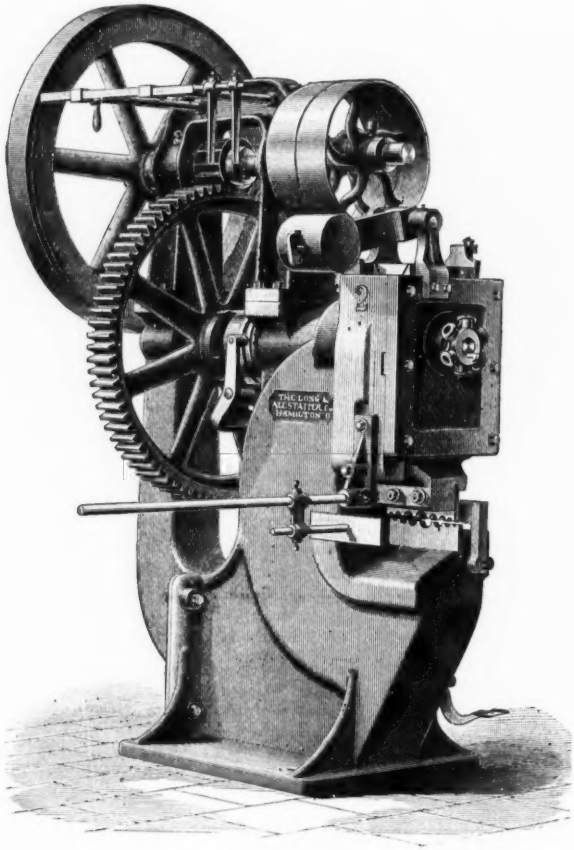


now using them with very satisfactory results. These machines, and other Sullivan diamond drills of all kinds, are sold by the Diamond Prospecting Co., whose main office is at Nos. 15–17 North Clinton Street, Chicago, with western office at Eighteenth and Market Streets, Denver, Col., where drills can be seen in stock.

### Heavy Bar-Iron Shearing Machine.

The machine herewith illustrated was lately brought out by The Long & Allstatter Co., of Hamilton, Ohio, for cutting up bar iron. This company manufactures this machine in several sizes, the heaviest design for cutting four-inch bars. The machine shown in the illustration is for cutting up bars up to 1¾-inch round, and is driven by belt. In some cases the makers apply to the machine a self-contained steam-engine to operate it. This tool is constructed upon the principle well-known in connection with the punching and shearing machines manufactured by the above-named company, the movement being by steel cam-shaft running in bushed bearings and operating on the slide through

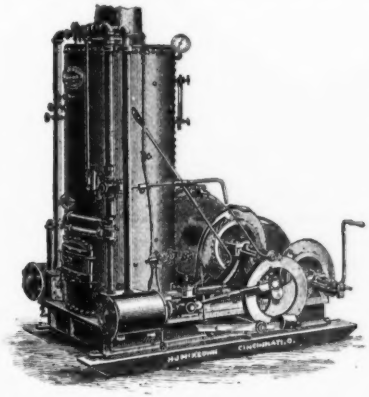
steel pendulum having gun-metal bushings. The slide is counter-balanced and the cam-shaft can be quickly turned by hand, by means of a capstan-bar in front, to facilitate the setting of the shear-blades. The machine has been designed to take up the least possible amount of room, there being none of the usual rearward projection of the tight and loose pulleys, these in the present case being arranged directly over the machine. The automatic "stop-motion" causes the slide to come to rest at the completion of the up-stroke, thus leaving the shear-blades open and permitting the accurate adjustment of the work. The shear-blades are arranged for very convenient attachment and removal. An adjustable gage is provided for gaging the length of work, and the lower jaw is arranged with a slope so that the cuttings readily fall from the machine. In front of the shear-blades is a very rigid hold-down which prevents the tipping up of the bar as the upper blade descends.



### An Improved Hoisting Machine.

THE improved type of hoisting machine which is illustrated on next page has met with wide approval in practical use. The boilers furnished with this engine are of

the submerged type; *i. e.*, the flues are always covered by the water and consequently the possibility of leakage is obviated to a large degree, while the flues require no cleaning. The boilers are made of the best boiler steel (60,000 tensile strength) and those of sizes of 30" to

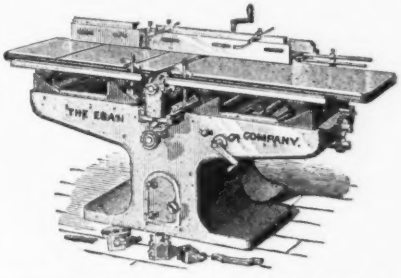


40" and 7½ feet long are made of one sheet, with seams double riveted, stayed at both top and bottom with three hand-hole plates for cleaning. This of course makes them more expensive than the ordinary flue-boiler, but much more durable. The engines are of the plain slide valve pattern, with the steam connections so arranged as to equalize the pressure on both cylinders alike; that is to say, the condensation accumulated in the steam pipes from the stopping and starting is so divided between the cylinders that it enables the steam to act immediately on the cylinder ready for work; the advantage of this is a quicker start with more power than any other engine. The friction is greater than that of other first-class hoisting engines, giving great bearing surface and more ease in application; the spool is loose on the shaft, the friction is applied by means of a lever screw on the end of the same and is connected with a steel pin, cross-key and collar. The same lever applies and releases the friction, and in the latter case allows the spool to freely revolve, making a perfect separation and preventing all possible danger of accident by the frictions sticking together; this is done entirely by means of the lever, no spring of any description being employed. The friction blocks are made of seasoned hickory bolted to the gear-wheel which is keyed fast to the spool shaft. Each spool shaft is provided with a wrench head, and when two spools are run on one engine, one runs loose on the shaft; a clutch being used to attach or detach it. The simplicity and advantage of this engine can be readily seen, and any man of ordinary intelligence can successfully run it. This hoisting machine is made by H. J. McKeown, Cincinnati, Ohio.

### Large Universal Wood Worker.

THE engraving herewith represents the latest improved wood worker, especially designed for heavy and light work, possessing all the advantages of the No. 1 and No. 2 machines, but of greater capacity. It will be found especially adapted to car work, agricultural work, general wood working purposes, and for dressing and taking out of twist large timbers and plane perfectly true, a right angle at one operation. The main head is slotted on all four sides, and is 19½ inches wide, and running in connection with the four-sided upright head, makes a very desirable machine for general use, and gives the very best of satisfaction.

The column is one complete casting



cored out, heavily braced and with ample floor space, insuring steady running, free from vibration when the mandrels are running at high speed. The tables are of extra width and length, planed perfectly true, and made with wide grooves to secure the gaining and paneling frames, and

exactly at right angles to the cutter head. Either table can be raised and lowered independent of the other, or can be raised and lowered together on a circle of the head, or straight up and down. All of these adjustments are made from the working side of the machine close to the cutter head, which allows the operator to make the necessary adjustments without going to the end of the machine.

The mandrels are of the best quality of steel, running in self-oiling boxes, lined with best genuine Babbitt metal. The main mandrel is of larger diameter, with the pulley on same running between the two back bearings. The front bearing is adjustable and can be taken off instantly when a change of heads is desired. This mandrel is also fitted up with our patent adjustable bearings, by which the boxes, with mandrel and head are moved back and forth across the bed, as desired, instead of making the adjustment by means of the fence, which will be found a great advantage and a great saving in time.

The patent beveling fences are made to adjust across the tables. One fence placed over the main head, and one back of the upright head. Both are made with sliding plates, and when beveled the lower part is close to the tables and so constructed as to have no forward motion. It is also arranged to take in posts and springs for holding down the stock while being passed over the cutter head.

The boring attachment on the opposite side is perfectly independent in operation. Two men can work the machine at one and the same time without any interference. It is capable of doing all kinds of boring, routing, rosette making, dovetailing table slides, and a general run of this kind of work.

The machine is furnished complete for ordinary work, such as planing out of wind up to 19½ inches wide, and squaring one edge up to 4 inches thick, at the one operation, also for surfacing straight or tapering, beving, jointing, rabbetting, making glue joints, either concave or convex; also circular, straight and wave moldings, chamfering, routing, boring, as well as gaining, grooving, panel raising, ripping, cross cutting, rosette cutting, etc., can be done to best advantage on this machine. Built by the Egan Company, 212-232 West Front street, Cincinnati, Ohio, U. S. A.

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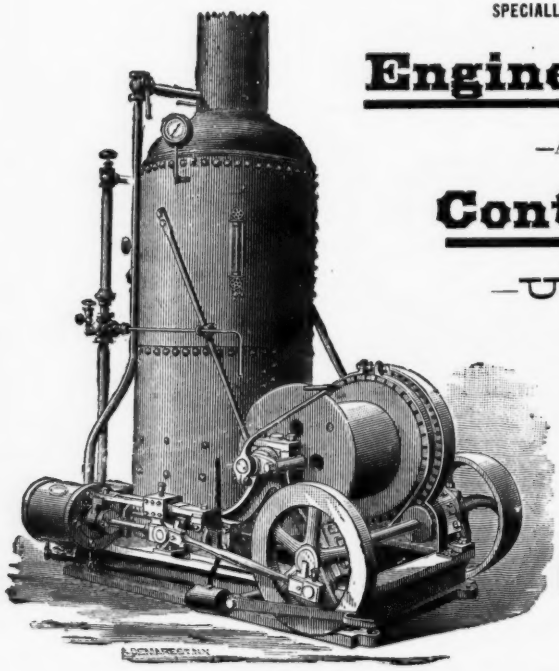

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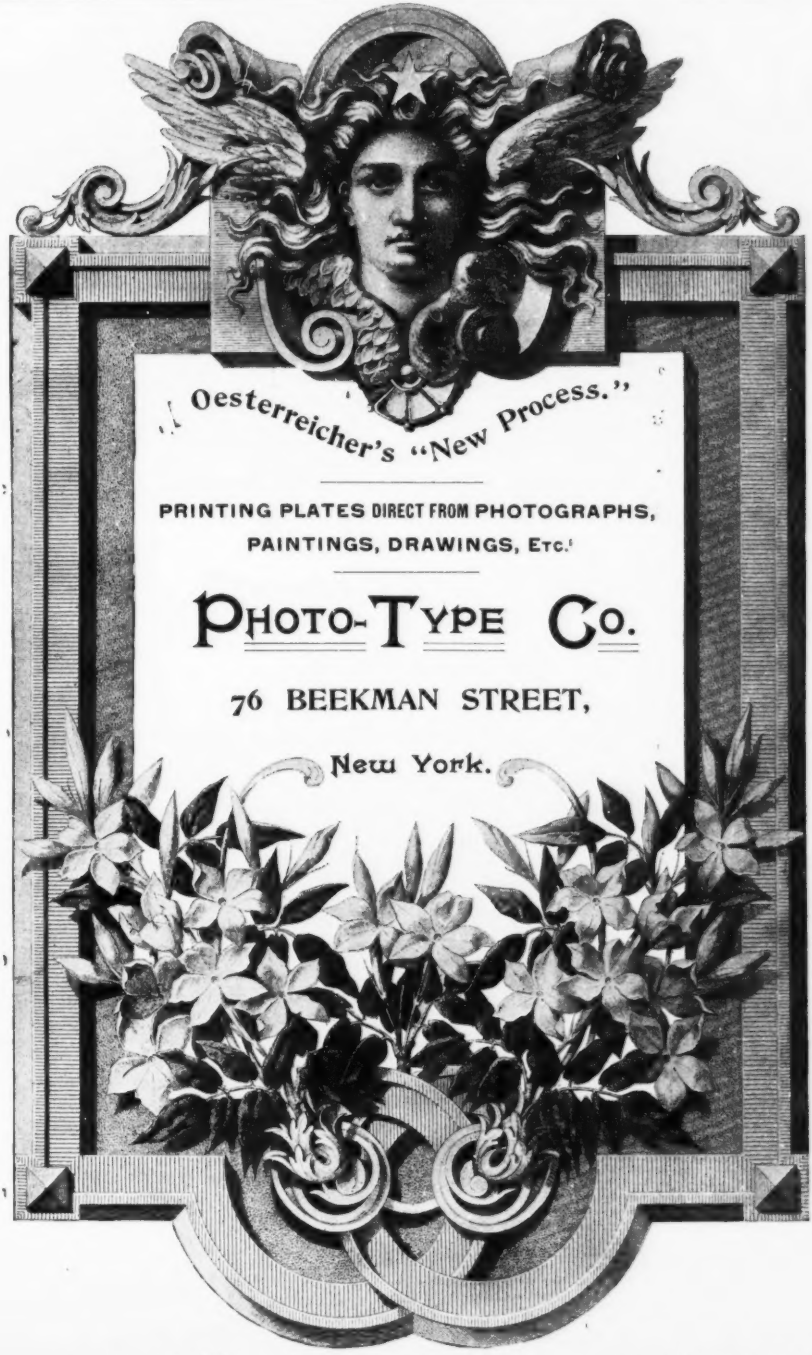
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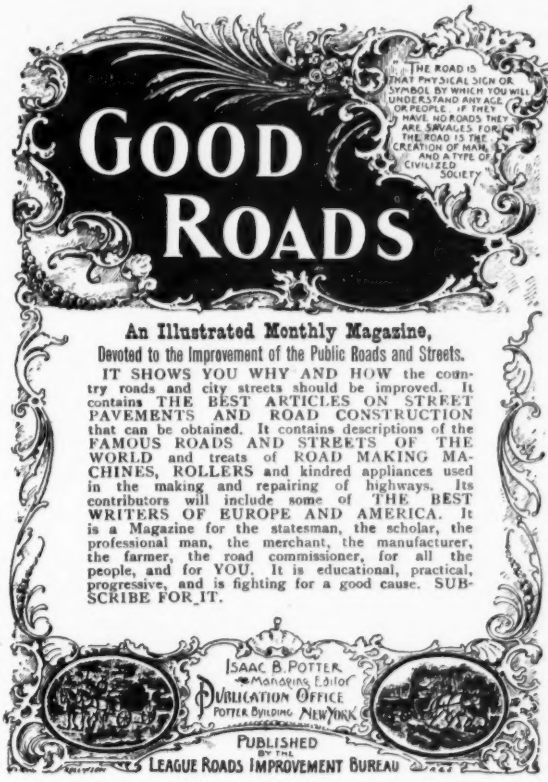
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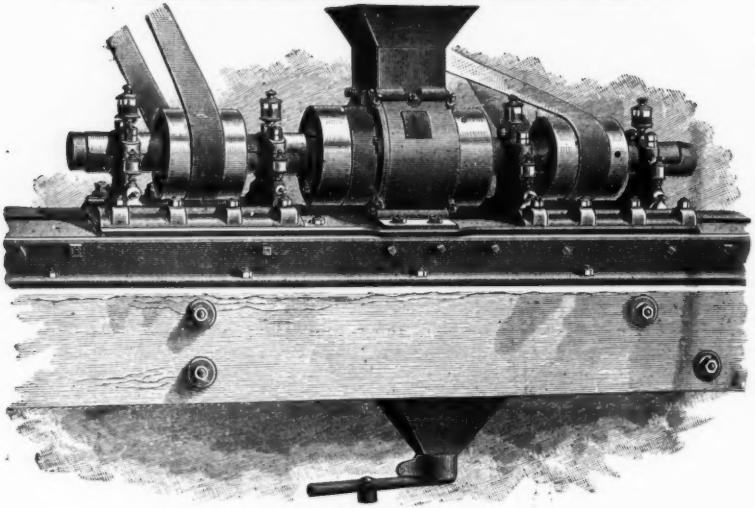

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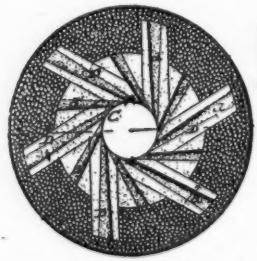

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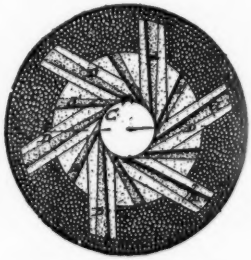

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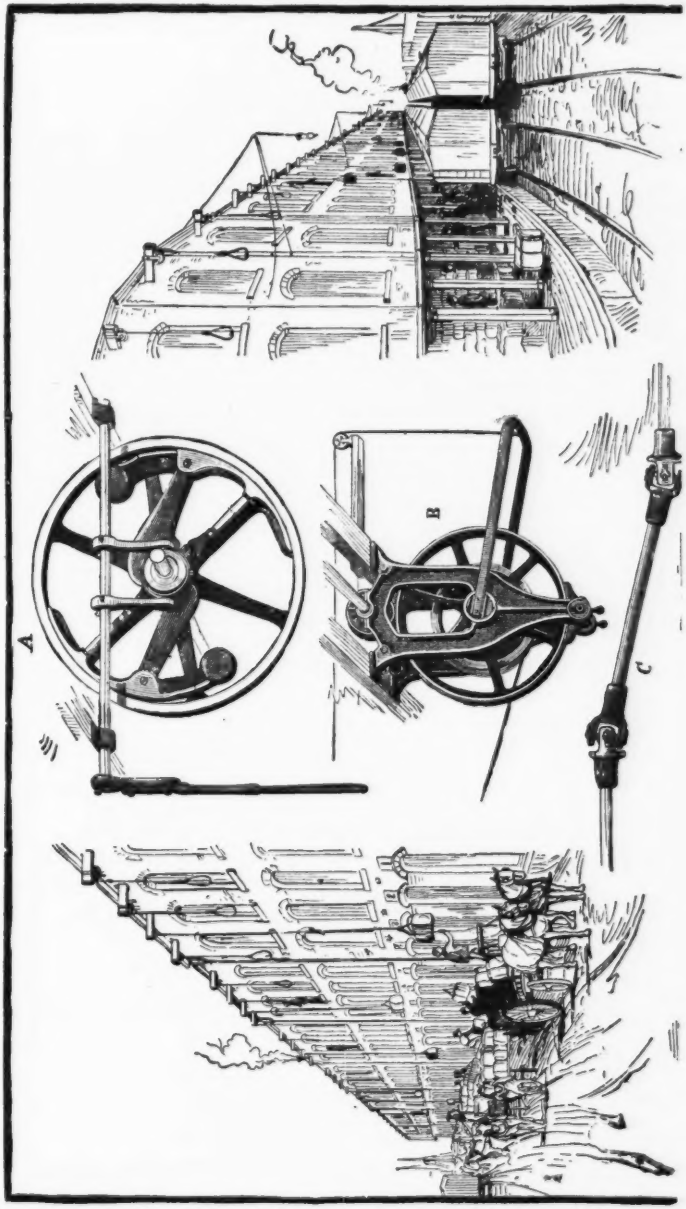


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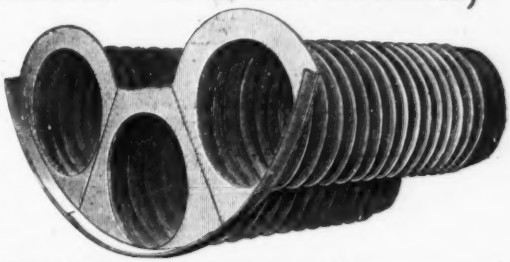

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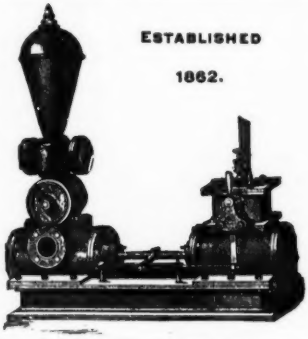

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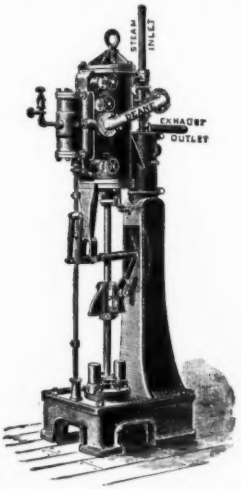


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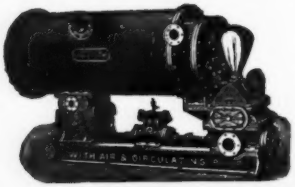

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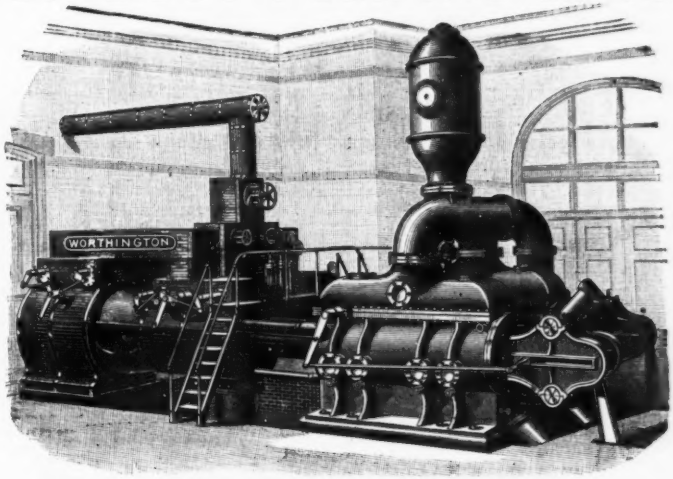


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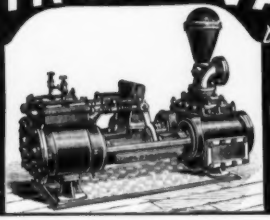

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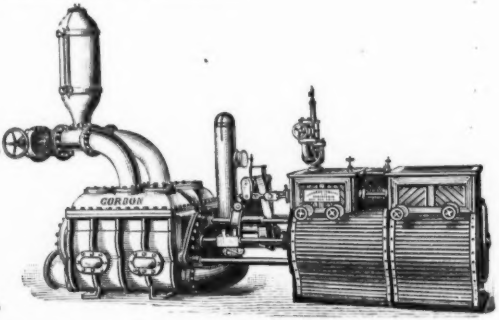


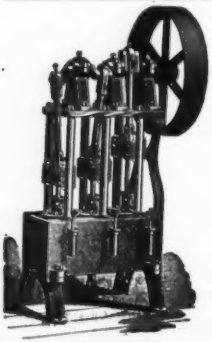

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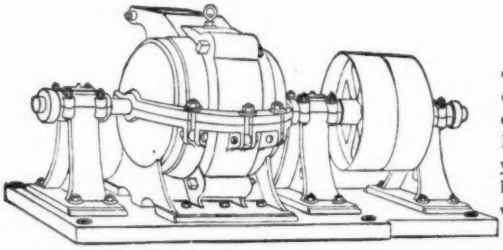

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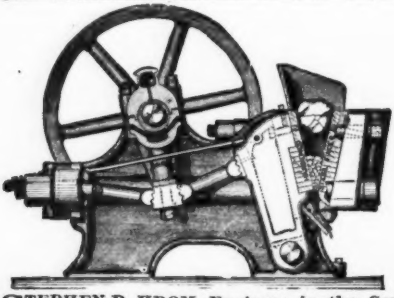

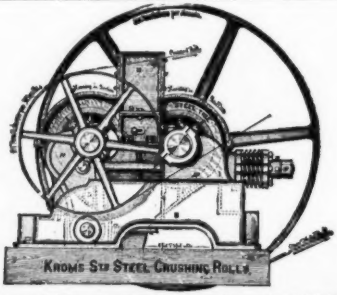


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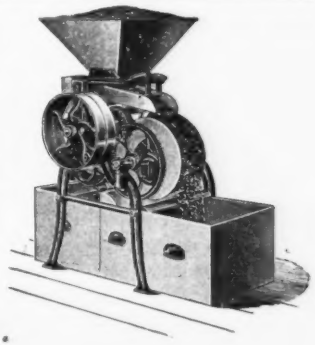

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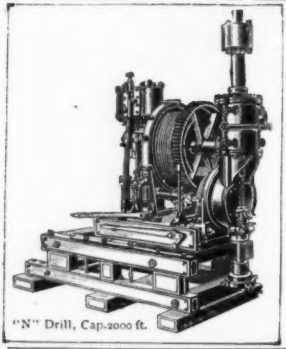
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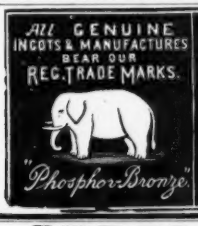


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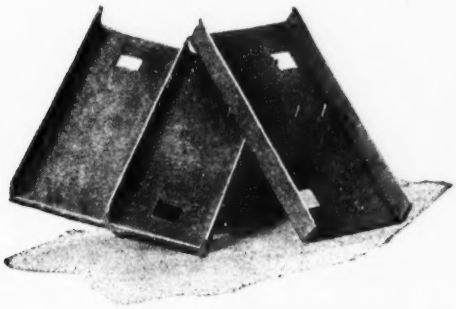

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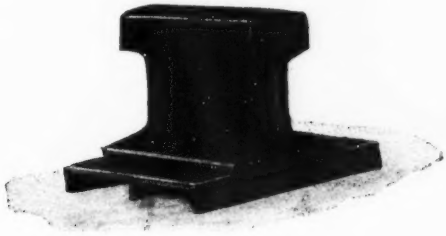

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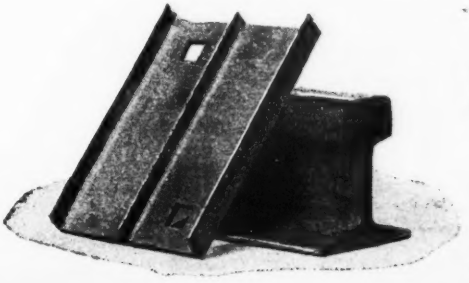

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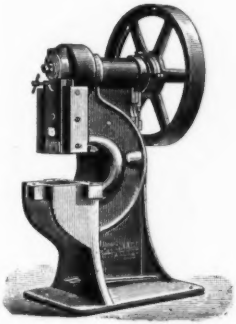

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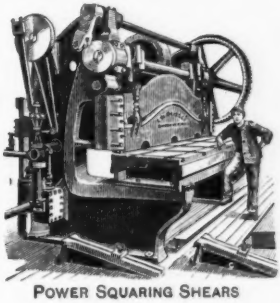

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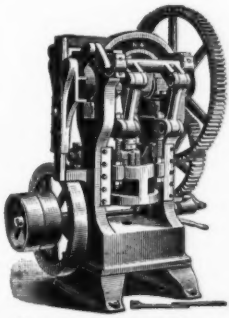

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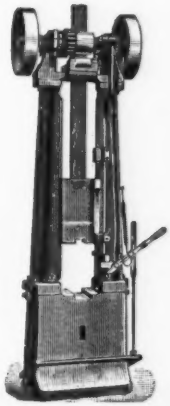

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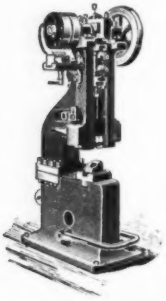

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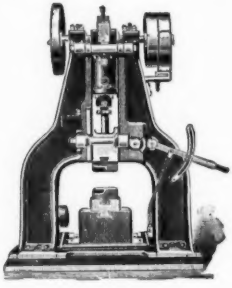

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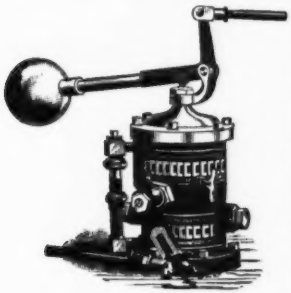

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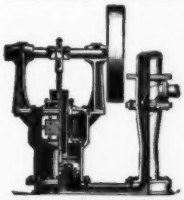

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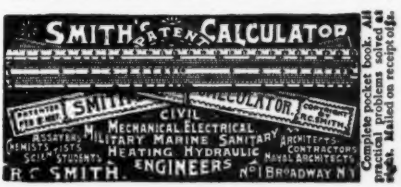


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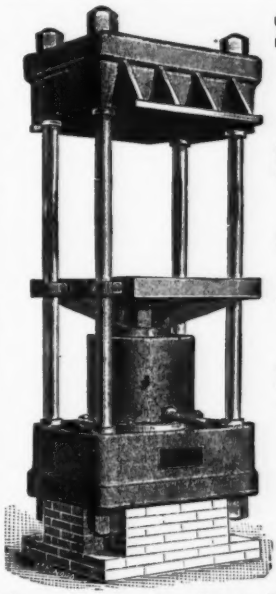

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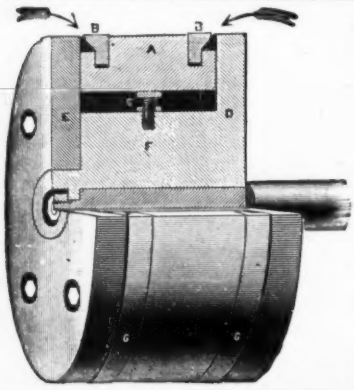


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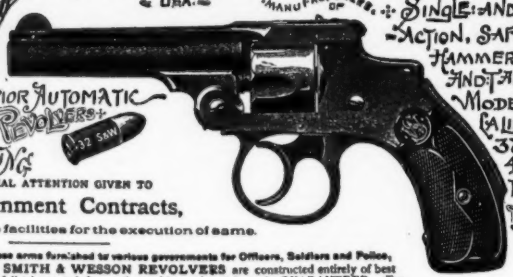


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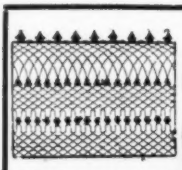

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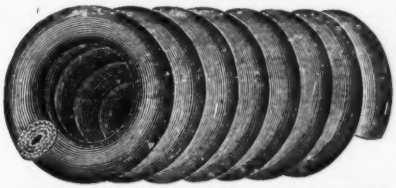

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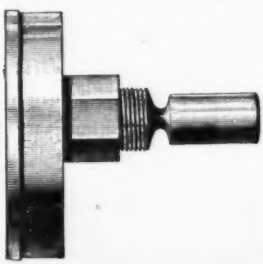

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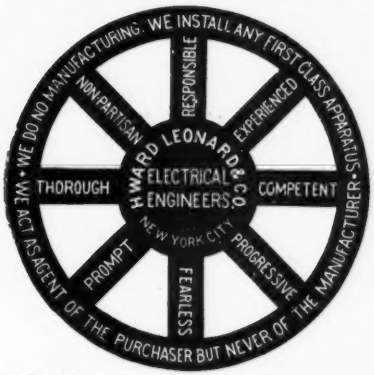


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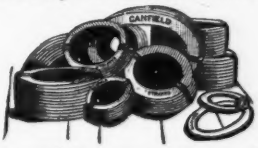


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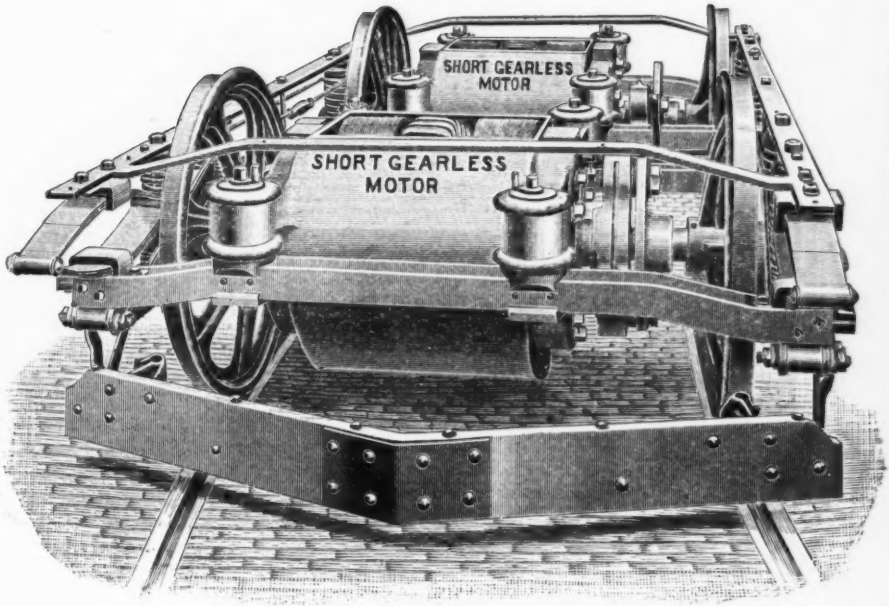


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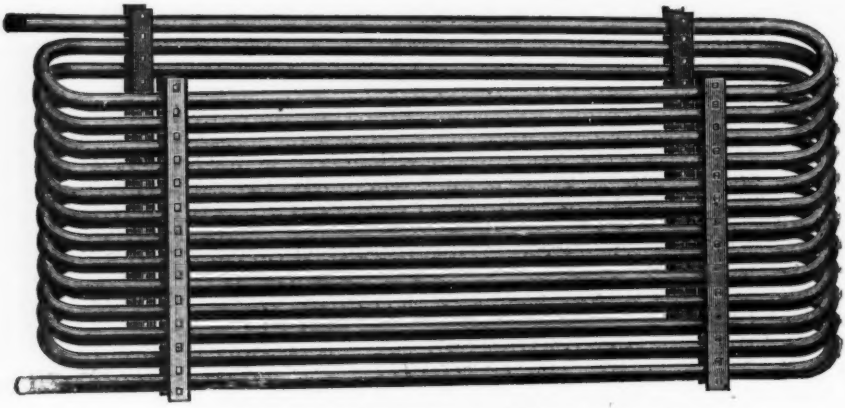

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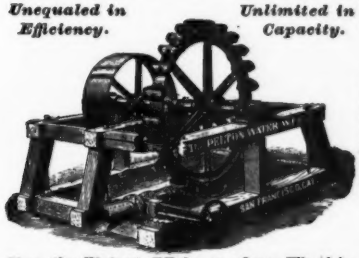

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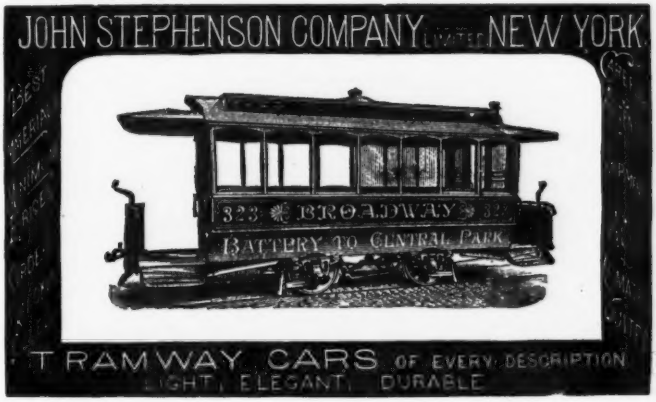


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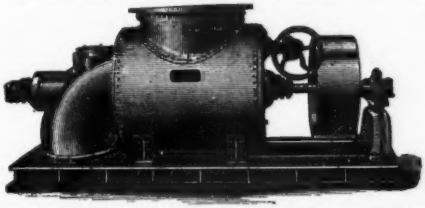

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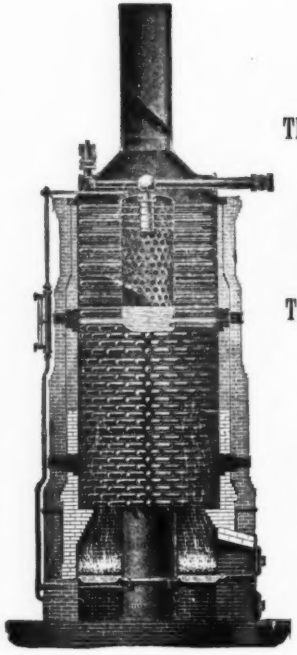

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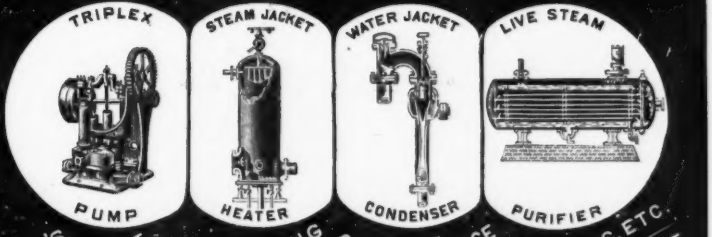


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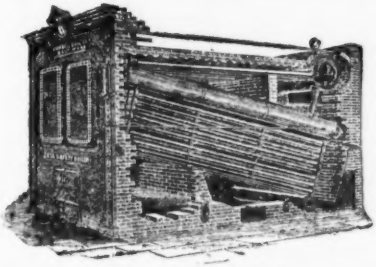

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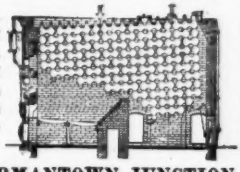

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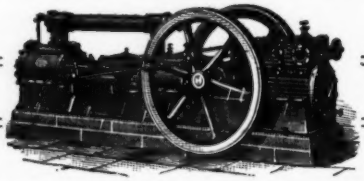

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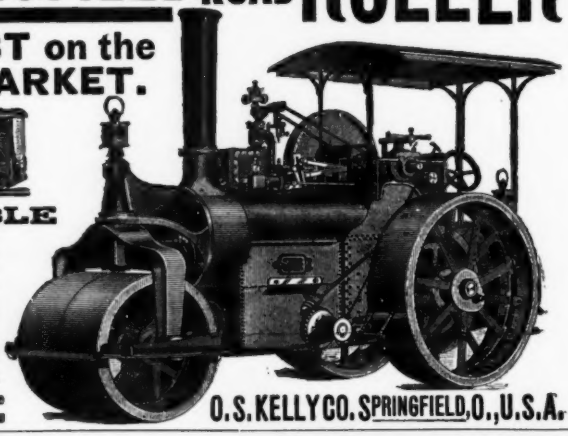

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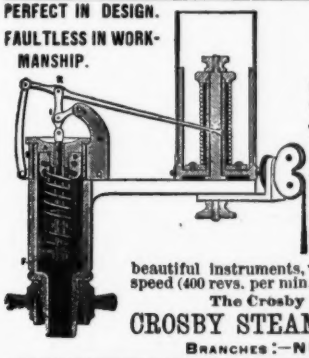

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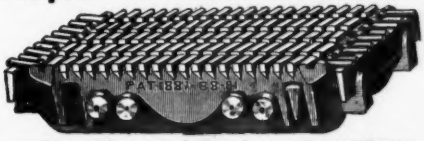

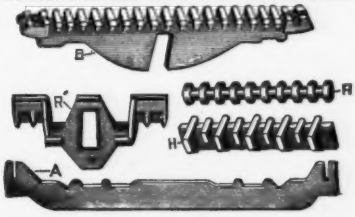


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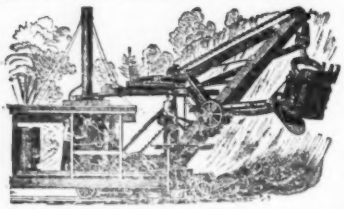

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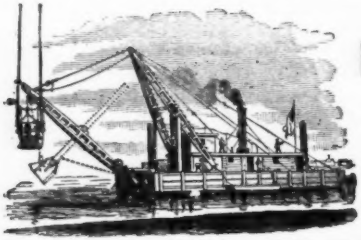

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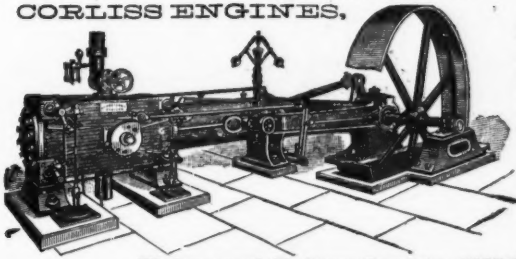

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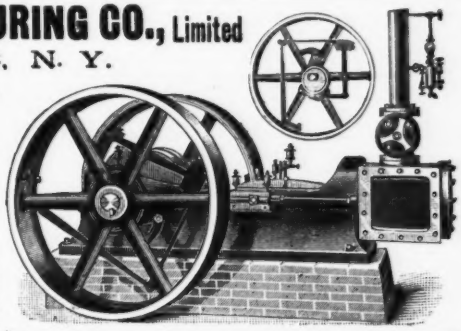

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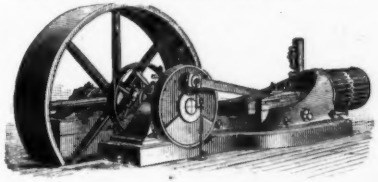

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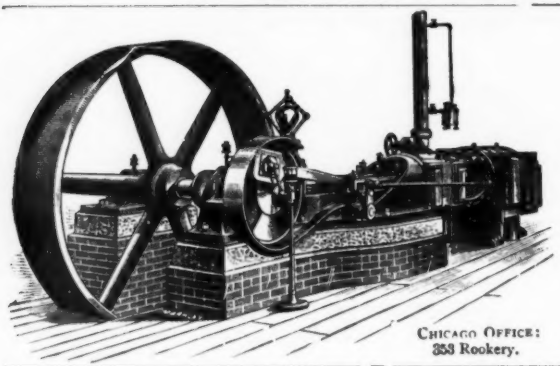

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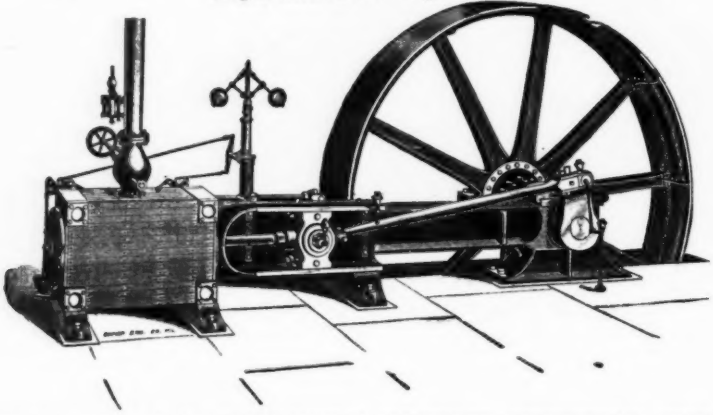

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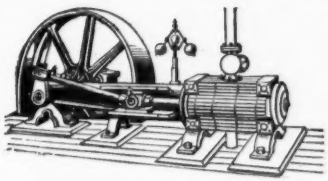

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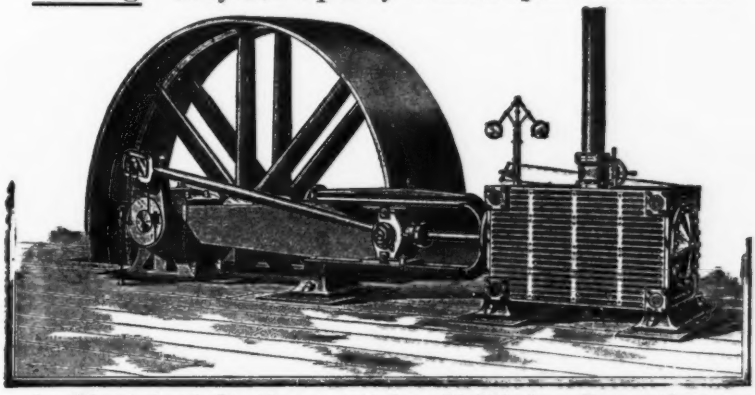

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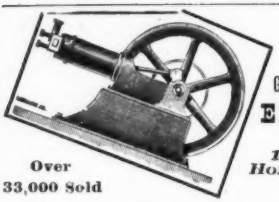

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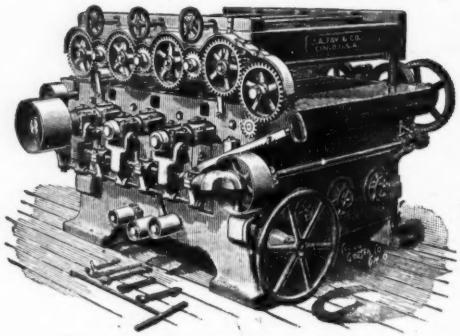

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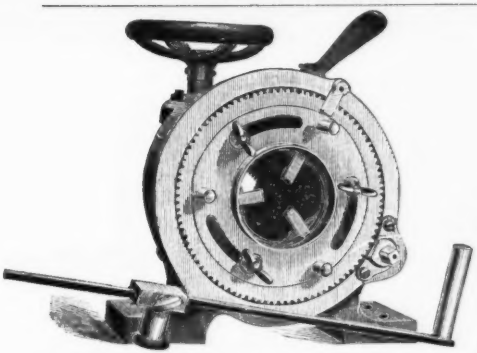

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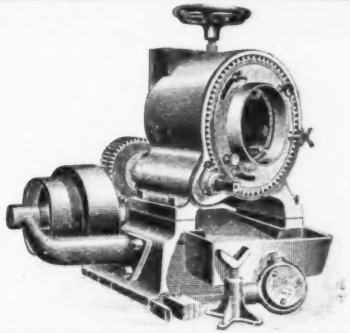

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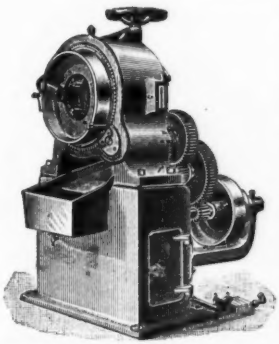

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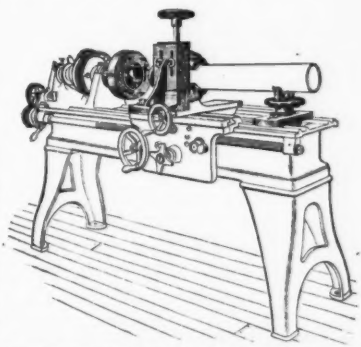

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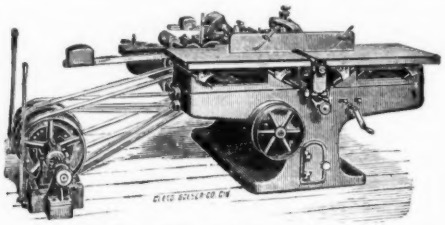

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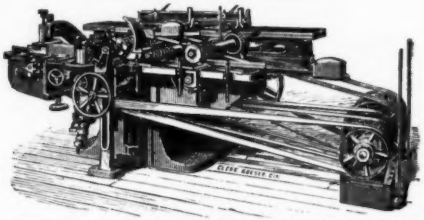

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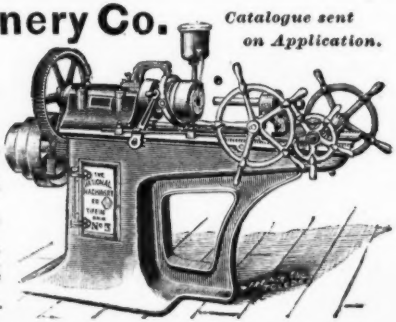

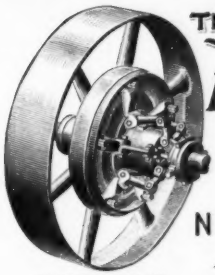

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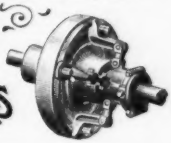

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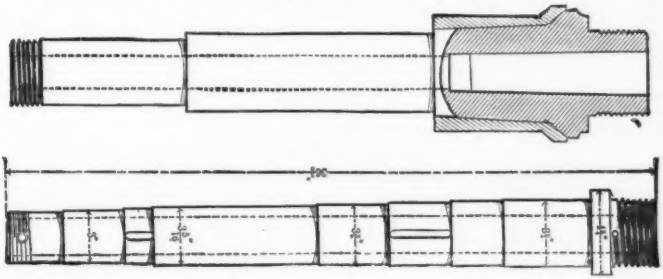

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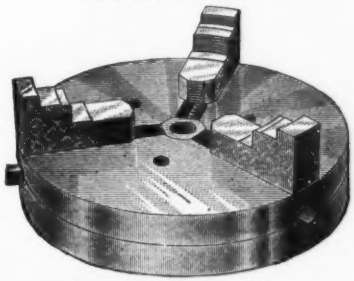

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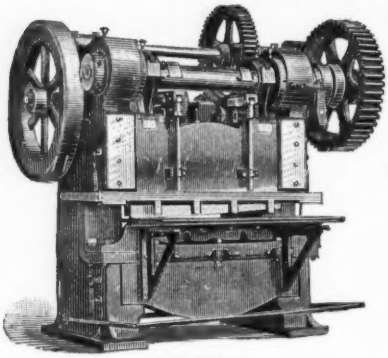

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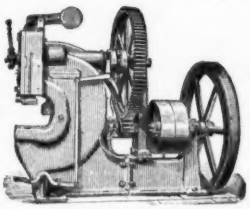

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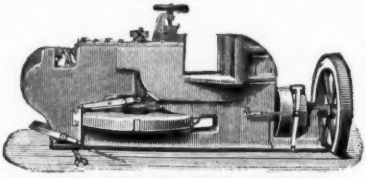

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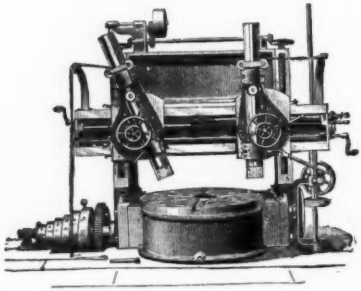

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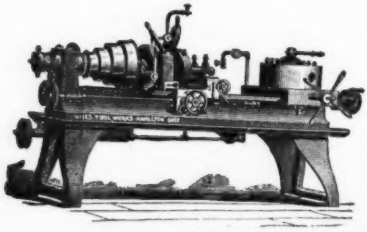
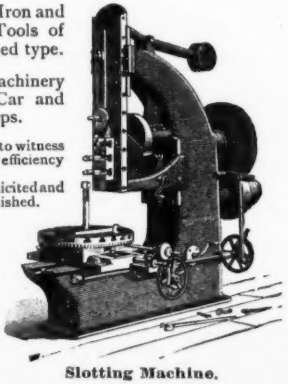


**Screw Machine.**



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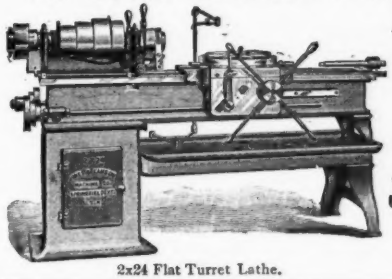

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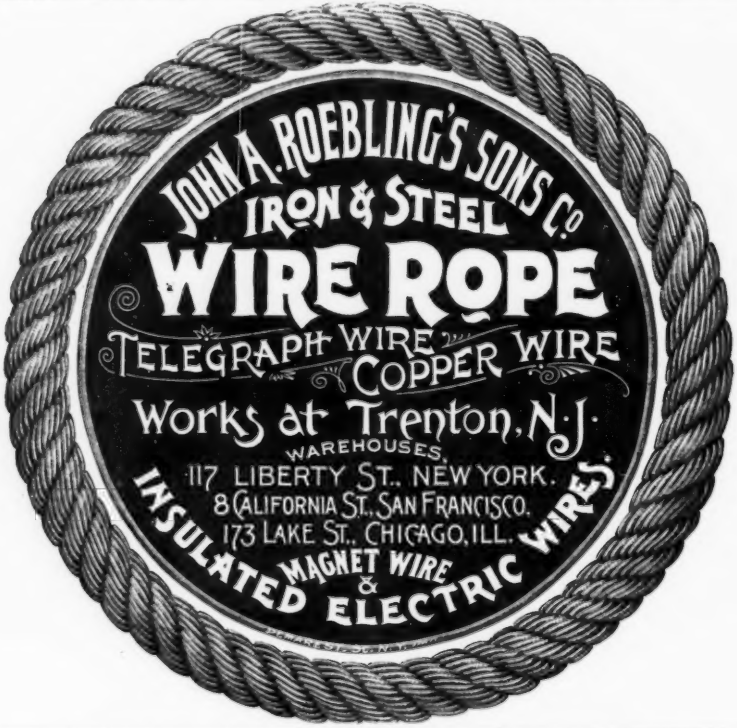


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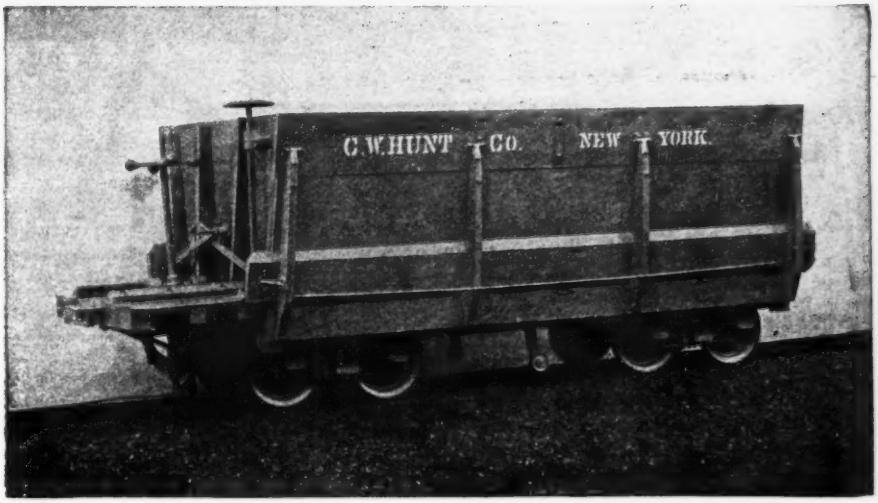


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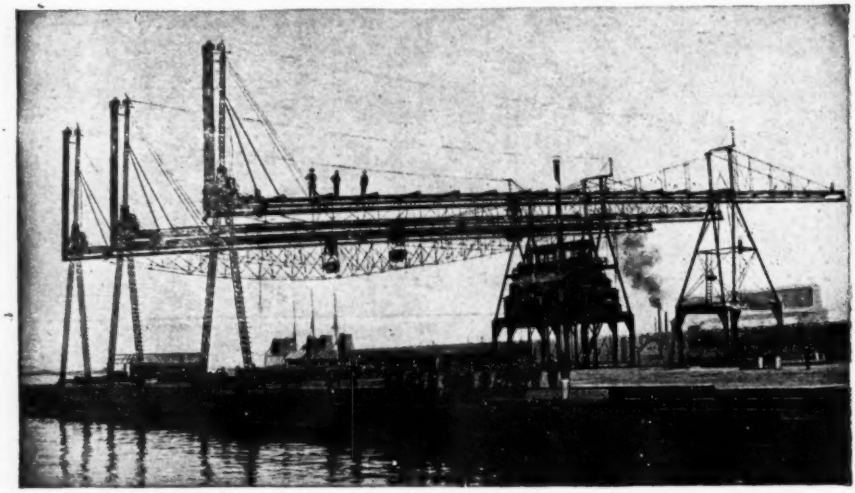
**Of the Patents, Applications and Designs under which the Brown Hoisting and Conveying Apparatus and the various Tramways for it are built.**



THE BROWN PATENT MOVABLE BRIDGE TRAMWAY HOISTING AND CONVEYING APPARATUS FOR THE RAPID HANDLING OF COAL AND ORE AS APPLIED TO THE OHIO CO.'S DOCKS, WEST SUPERIOR, WIS.

Tramway Projection over Vessel, 34 ft. Clear Span of Bridge, 174 ft. Cantilever Extension, 80 ft.
Height of Bridge at Front, 36½ ft. Total Length, 291 ft. Height of Bridge at Back Pier, 52 ft.
The back piers of this plant span over two railroad tracks, permitting cars to pass under.

**THE ENTIRE PLANT IS MOVABLE ON TRACKS PARALLEL TO DOCK FRONT.**

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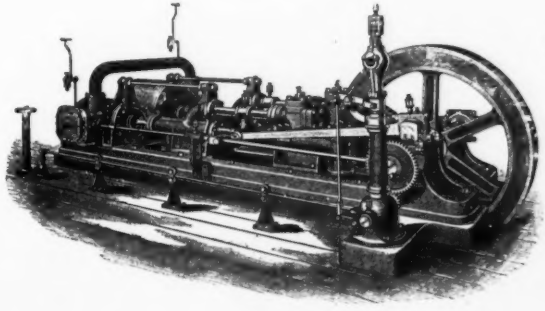

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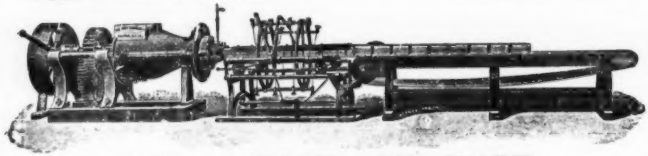

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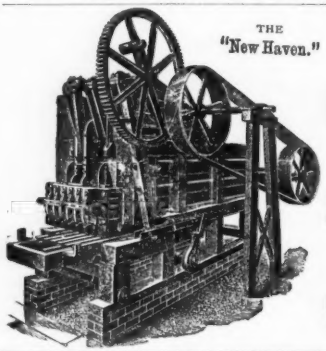

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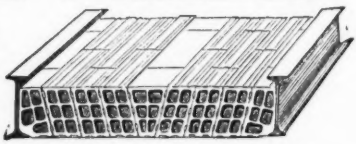

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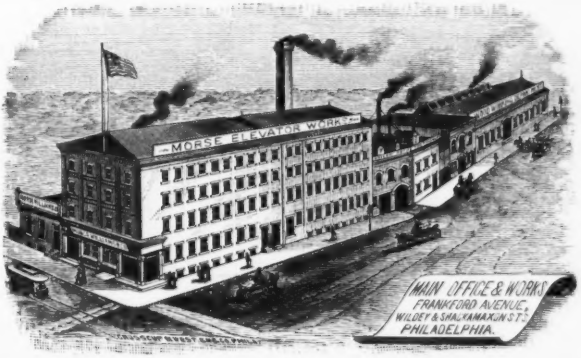


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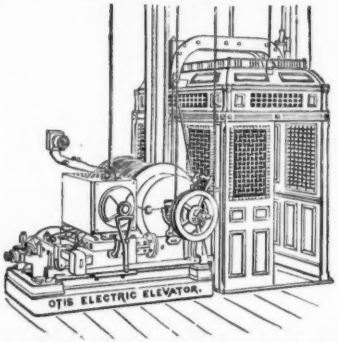


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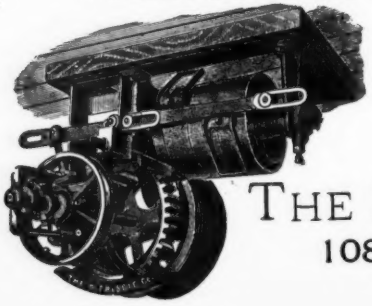

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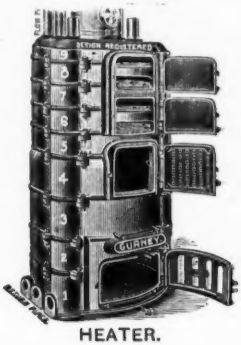

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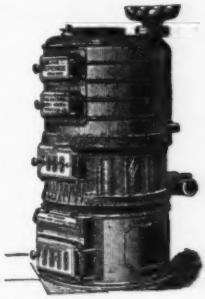

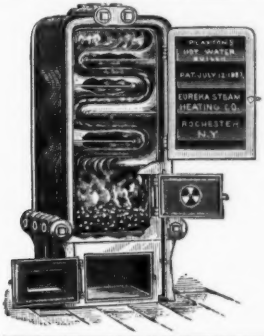


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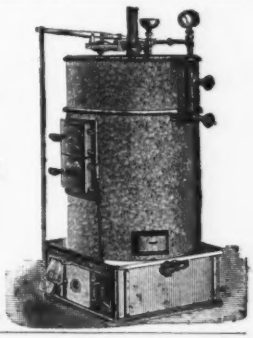

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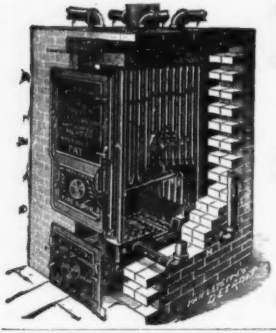

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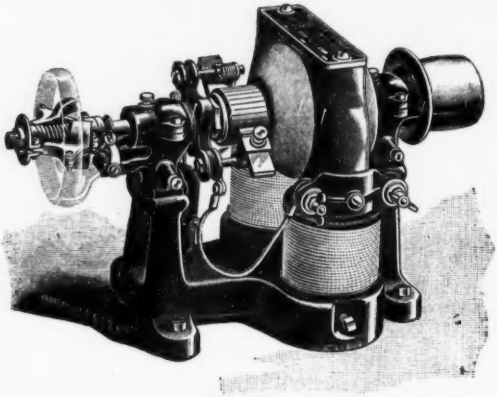

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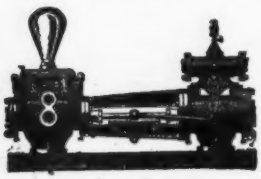

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